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SCHOOL SCIENCE AND MATHEMATICS

VOL. XXIV, No. 2 FEBRUARY, 1924 WHOLE No. 202

THE BUSINESS OF SCIENTIFIC CURRICULUM MAKING IN SECONDARY EDUCATION[1].

BY JOHN A. CLEMENT,

Northwestern University, Evanston, Ill.

1. FOUR FACTORS INVOLVED IN RECONSTRUCTED SECONDARY EDUCATION.

For a decade or more, an increasing interest has been manifested in the technique of curriculum formulation in secondary education. There is now no indication that this interest will wane in the near future. It has been waxing stronger during the last half decade. Scientific curriculum making is slowly but gradually becoming recognized as a gigantic and important school business worthy of the attention of educational experts, and of the most competent school administrators and of other school practitioners.

This stupendous project of reorganizing our secondary schools so that they will function most satisfactorily in the midst of new problems—social, economic, industrial, and political—involves many factors. One of these factors has to do with a restatement and re-evaluation of general and specific objectives of education as a whole, extending from the end of the first six years of the elementary school to the end of the first two years of college, namely, the junior college. We have as yet outlined but the preliminary array or draft of these objectives. A second factor has to do with the reorganization of our traditionally and accidentally made 8-4 educational ladder into some form of a non-8-4 adjustable educational plan. This plan is now represented most widely by the idea and spirit expressed through the junior-senior high school movement of America. And though fifty per cent of junior high schools may at the present time represent largely camouflage reorganization, the other

[1]Read before the Illinois Academy of Science at Galesburg, 1923.

fifty per cent, have, to say the least, caught up the spirit of the need of the adjustment of aims and materials taught to the present-day social demands of the learner.

A third factor has to do with the significant psychological problem of the adaptation of subject matter, offered and taught, to the capacities of different groups of pupils possessing varying abilities and achievements. Up to date, we have made comparaively a very meager beginning in the matter of the presentation of subject matter to that group of pupils who possess exceptional ability in our schools. The wide use of general intelligence tests and of educational measurements within school subjects has assisted considerably in helping educators to sense this problem. The task is not more than half completed, however, when pupils have simply been grouped according to capacities or abilities. For the administration of subject matter so that each pupil in any group may use up all of his potential ability is a problem which is as yet far from being solved under our usual line-of-march, lock-step practice. A fourth factor has to do with the nature or types of reconstructed subjects and the corresponding subject matter to be offered throughout the whole six years of the so-called junior and senior cycles of secondary education, including, in time perhaps, also the first two years of college.

The mere enumeration of these four factors brings into bold relief four challenging problems in secondary education—problems suggested in crude form as early as the time of Plato of the Ancient World, and continued in clearer form during the later days of Comenius of the Modern World, but now transferred into the midst of new settings infinitely more complex. To some persons the above factors or problems will appear to be but the platitudinous statement of educational aim, organization, method, and subject matter, respectively, of the past history of education. But they represent much more than this. What is the best way out and ahead? Is one educational move better than another? In the matter of formulating objectives, we have made our largest progress at the present time in secondary education. These are not wholly satisfactory measured in terms of finality.

II. The Redetermination of Educational Objectives.

Curriculum construction and the determining of educational objectives are inextricably bound together. The matter of scientific curriculum making has not as yet been carried very far ahead But we have made an encouraging beginning. In the

past, tradition and formal discipline have been the two outstanding criteria used for justifying the inclusion of certain subjects in the program of studies as a whole, or in different curricula. Both of these criteria have now been reduced to the minimum. Every secondary school subject, at one time or another, has been let into the list of offered subjects either on one or both of the above grounds or counts, namely that of tradition, or of mental discipline. But the point of emphasis has now been shifted so as to include a complex of objectives involving cross-sections—not mere sectors—of the whole of an individual's experience at different stages of his in-school and post-school careers.

Through such cross-sections of meaningful experience, an attempt is being made through the presentation of school curricula to summarize and interpret the activities of modern civilization and all of its dominating phases—scientific, social, civic, linguistic, literary, vocational, aesthetic, moral and religious. Modern curricula should represent a series of surveys of the whole of the experiences of civilization at varying pupil levels throughout the six or more years of secondary education. Spinning wheel customs were different from those which we find in our own aeroplane days of multiplely-inter-related interests of one sort or another. Curricula that once represented simple experiences must represent now complexes of many interests, ideas and ideals.

In the midst of differing environmental conditions and the varying problems of one community from one generation to another, or the varying problems within the same generation, a reliable method of procedure in determining present day worthy educational objectives is to be found through making an analytical survey of all of the activities involved within a given time, area, or community, which bear upon the educational experience of the learner.

Seven objectives have been outlined by the N. E. A. Committee in the "Cardinal Principles of Secondary Education," published by the Bureau of Education, namely: (1) Health, (2) Command of Fundamental Processes, (3) Worthy Home Membership, (4) Vocation. (5) Citizenship, (6) Worthy Use of Leisure and (7) Ethical Character. Professor Bobbitt has added two objectives to this list, and contends, furthermore, that it is possible to break up these general objectives into a long list of specific or particularized aims. One of the Committees of the North Central Association, representing unit curricula, has outlined four objectives which represent a composite of those out-

lined by the N. E. A. Committee. Professor Inglis outlines three. Professor Charters combines ideals and activities as essentual in the construction of curricula. Professor Bonser evolves all curricula for elementary education out of the world experiences which have come to have meaning for the pupil. Professor Snedden believes in the sociological determination of objectives. The Illinois High School Conference adopted a fourfold set of objectives having to do with health, wealth, association, and esthetic experience.

So far there have been several profitable outcomes of this attempt to redetermine objectives. These aims of education are less vague than were most of those which appeared in the past history of education. In the next place, there is a distinct consciousness that the analysis of the activities in which pupils do and will, and should engage, cannot be ignored when making curricula. In the third place, it is recognized that certain objectives, whether they be three or four, or seven, or nine or more in number, should be regarded as common or universal for all individuals at certain stages of their educational careers, no matter what may be their later vocations or occupations. No subject matter can be justified per se, apart from the pupil's psychological and sociological needs. Curricula, when outlined apart from consciously recognized common and universal objectives in the junior high school years of a pupil's schooling, represent an enormous waste of time and effort.

III. Junior-Senior High School Curricula in the Making.

The previous remark with reference to the necessity of agreeing upon certain common and universal objectives is especially applicable to the three-year junior cycle of secondary education. Out of the score of arguments, which have been made in defense of the junior high school idea or spirit, the reorganization of subject matter is one that is of relatively large importance. The growth in the number of junior high schools has been so phenomenal that in many, if not in most instances, real curriculum reconstruction has not yet been accomplished. On the other hand, there are several large cities, and a number of individual schools, that have modified the nature of the content very materially.

Such modification is inevitable if once it be granted that the subject matter should be related to the objectives outlined. Furthermore, it means the elimination of certain non-functioning materials from certain subjects, as well as the addition of

other phases than the mere traditional subjects. Dismissing for the moment the debatable issue as to whether the secondary school should have an inflexible curriculum or differentiated curricula, there is large agreement to the effect that at least the first two years of the junior high school should offer a common body of knowledge which serves as a time of exploration and adjustment for the pupil.

To determine upon the proportionate amount of time, if any, to be given during each week to English, general mathematics, general science, introductory social studies, health, or physical education, industrial arts, home economics, music, art, guidance, occupational studies, and school activities, is one phase of the curriculum making problem. To determine upon the nature of the larger units of subject matter and their sequence to be offered under the above named subjects in the light of a half dozen or more accepted common objectives is another important phase of curriculum construction.

The above enumerated subjects represent a composite list taken from several typical junior high school programs of studies One city suggests a percentage distribution of curricular time such as follows in the so-called general curriculum of the junior high school:

	B	A
Health (gymnasium work, hygiene, safety education)	16.6	16.6
Auditorium (centralizing, integrating, curricular activity of the school)	6.6	6.6
Social science (history, civics, elementary economics, and sociology)	16.6	16.6
Exact science (mathematics, general science)	23.3	20.0
Languages (English, foreign languages)	16.6	13.3
Vocational (shops, mechanical drawing, home economics, commercial)	13.3	20.0
Fine Arts (art, design, music)	6.6	6.6

The adaptation of subject matter to the individual differences of pupils is worthy of consideration in the junior high school cycle as well in the senior cycle and will be referred to again under the next section.

However, before leaving the topic of curriculum construction with special reference to the junior high school, one suggestion is worthy of further consideration. One almost unpardonable sin committed by the traditional curriculum formulator was that he planned separate compartment programs of studies for the elementary, secondary, and higher schools, respectively, and so unduly vivesected the pupil's learning process. Another sin of almost equal proportions and closely related to the first was that of the mere duplication and repetition of subject matter on non-

increasing psychological levels. In the remaking of the curricula of secondary education, there should be no abrupt demarcations represented between elementary and secondary schools, or between secondary schools and junior colleges. Education should be regarded as a unit in the large, divided for convenience of administration, into sub-units. This leads naturally to the statement that each pupil should be well trained in a sequential order in two or more subjects throughout the secondary school. In this way the principle of progression and sequence can be utilized in the organization of subject matter. One outstanding limitation and weakness of the program of studies of the junior high school at the present time is that in the minds of many persons, it merely represents a mass and maze of the so-called enriched curriculum materials which have accumulated in such fields, for example, as general science and social studies. The arrangement of this material in sequential order, both within the junior high school and in the transition to and beyond the senior high school is essential to real success. For instance, what certain experimental schools are attempting to do in the sequential arrangement of two or more years of history is necessary also in the social studies other than history, and so on through the round of the other school subjects which are taught in both the junior and senior cycles of secondary education.

IV. The Adaptation of Subject Matter to Individual Differences.

It is obvious that the adaptation of subject matter to the different and varying abilities of pupils is as much, if not more, a problem of methodology than curriculum making. It is equally evident, however, that the curriculum, when considered apart from the child, is of little consequence. Our practice, too frequently, has represented the curriculum versus the child, or the child for the sake of the curriculum, whereas we are now convinced that the curriculum must exist within the child, or for the sake of the child.

Perhaps the most ready single means for detecting the varying abilities of pupils is through the use of intelligence tests. Through the distribution of these psychological scores, it is possible to classify pupils somewhat reliably into homogeneous groups. As many other means as feasible—educational measurements, teacher's marks and estimates, etc.—should be used to assist in classifying as accurately as possible the pupils within such groups.

As already indicated, the formulation of subject matter and the presentation of the same are inseparable. In practice, method and material are seldom, if ever, found separate. So far, two large plans have cared for most pupils in recognition of individual differences. In the first place, pupils have been grouped into sections having varying abilities, and have been allowed to cover a larger amount of ground in a shorter length of time. The measure in the past in the main has been the time unit which has been true very largely up to the present. In the second place, pupils in a limited number of school systems have been allowed to progress on the basis of the mastery of certain units of subject matter. In this instance, the chief unit of measure is achievement, not mere time. Promotion is based on merit, not the number of weeks in school. What has happened in most instances however, after pupils have been homogeneously grouped, is either the length of time has been shortened during which the work could be done, or the quantity of subject matter to be covered has been increased. That is, we have merely penalized the student for his brightness by asking him to do more work on exactly the same mental level as that on which the previous work has been done. Relatively speaking, little has been done in the way of real progress to change, not only the method of presentation for the superior group of pupils, but little has been done to change the actual quality of the content of subject matter offered.

The problem of the exceptional pupil is only partially solved when we have allowed him merely to finish in a shorter length of time because of his native brilliancy. He ought not only to be allowed, but to be given the opportunity through the formulation of appropriate subject matter to use up as nearly as possible all of his mental capacity just as is the more mediocre or slow pupil driven to do in the mastery of the ordinarily outlined material. Superior pupils have as much right to have an opportunity to use up on suitable materials all of the ability they possess as have the pupils nearer the other end of the distribution curve of native ability, who are compelled to work up to the limit of their capacity in order "to pass."

The outline of materials in terms of quality has as yet been very meagerly done, and should be kept in mind as a part of the project in the scientific construction of the program of studies as a whole. It is, of course, likely that even with this material of a higher qualitative type to be mastered than that found in the usual program of studies, the especially capable student

will still be able to do the work in less time than the mediocre student can do the work outlined for him.

To summarize, it is important that curricula in part be constructed so as to meet the common needs of all groups. But within the scope of secondary education, some attention should also be given,—much more than at present,—to outlining materials for those pupils who possess superior or exceptional ability. And this is no simple task of a few weeks or months. It involves the research and investigation of a decade of time, more or less. The emphasis which has been given more recently to individual instruction versus socialized and group recitations is, no doubt, an honest attempt to face the problem of adaptation of subject matter to individual differences of pupils. Curricula on the whole have been made for the pupils who have about a medium grade of intelligence. As a consequence, we have attempted during a great deal of the time to reduce all pupils to a similar level of achievement, pulling down those having exceptional ability and intelligence, and pulling up those having unusually low ability and intelligence.

V. The Determination of Curriculum Content through Experimental Research, and through the Investigation of Competent Committees.

Experimentation carried on through a period of four or five years at one time represents one reliable method of procedure in attempting to determine the nature of the content of curricula. In social studies, for example, this can be done as well as in other studies, such as natural science, mathematics, and so forth. In social studies, objectives should be agreed upon so far as is possible in advance of the experimentation carried on. One important general objective or purpose can well be that which has already been suggested by various committees, namely, enabling individuals to live and get along agreeably and successfully with one another. If once this objective be agreed upon, then all subject matter outlined and taught should point to this purpose and other purposes and sub-purposes, equally worthy of realization. Material as traditionally outlined in history and other social studies is not wholly satisfactory in the light of the purposes of the above sort.

Furthermore, it is essential to agree upon tentative large units of subject matter best suited to the realization of these newly stated social purposes. A dozen, more or less, of such units made up by selecting the content from a variety of sources

in the general field, extending from ancient times to modern, will constitute a more satisfactory curriculum pabulum, which will be superior to that which has been offered in water-tight compartment fashion. This is especially true in relation to the first three years of secondary education. Gradually more intensive work built upon the earlier larger units of subject matter can be outlined for the last three years or less of secondary education. This method of approach in social studies is but one example of what can be done in other secondary school subjects. The use of this larger unit of subject matter for the earlier approach in secondary school subjects constitutes a fundamental aspect which should be taken into account in our newer technique of curriculum construction.

More experimental schools than now exist should be established in different sections of our country, and endowed for the purpose of carrying on scientific curriculum experimentation and construction in secondary schools. At the present time only a limited number of such schools exist in widely scattered areas. There is no more important and worthy desideratum just now in our attempt to reconstruct secondary education in America than the matter of experimental research in relation to secondary school curricula.

The bureau of research, which has been established recently within state universities and in state teachers' colleges, can do considerable to bring the gravity of this problem of curriculum construction to the attention of progressive school people through statistical study and investigation of present practices in curriculum formulation.

A limited number of schools have attempted a tentative reformulation of all their subject matter taught. The cooperation of educational experts and of public or private school officers in curriculum making when well guarded and guided, should become an increasingly wide custom in the American secondary school system. More experimental schools should be created for the specific purpose of testing out the most satisfactory curricula. And, again, the plan of curriculum formulation which enlists the interests and efforts of a whole teaching staff in cooperation with an educational expert should be encouraged.

Within the last decade, it has become the custom here and there for school boards and superintendents to invite in educational experts to cooperate with the regular teaching staff

in making over the total program of studies offered. Obviously, one sensible procedure in such a situation is to make a survey of the activities, industries, enterprises, interests, and needs of the community involved. This includes the interests of patrons as well as of pupils. Another aspect of this procedure is the analysis and re-study by the teaching staff of all the materials offered by them in the light of widely accepted general objectives and corresponding specific sub-objectives in harmony with the psychological and social needs of pupils in respective communities. The presentation of such material will be superior to that which is ready made, handed down from too many generations back. We have now come to the time when we can well afford to committeeize the persons who are masters in one field or another throughout the country, and who are competent to work out the different courses of study to be offered within the program of studies and in the curricula of our secondary schools, and delegate to them the power to outline representative curriculum materials.

Each community in the main must work out its own curriculum salvation. Only those aspects of the curriculum will be uniformly standardized, which apply to common and universal objectives. Toward the end of the secondary school period, considerable leeway will be necessary, both for the adaptation of subject matter to meet individual differences in terms of capacities and aptitudes of pupils, as well as leeway in the adoption of curricula differentiated enough to apply to all of the varied interests of different communities.

VAGRANT X-RAYS CONFINED BY USE OF BARIUM PAINT.

Vagrant and injurious X-rays may be confined to the room in which they originate by the use of barium in plaster or paint, Maximilian Toch, a chemist of New York City, told members of the American Institute of Chemical Engineers meeting at Washington. Long exposure to X-rays which have escaped from doctors' offices through walls, floors, or ceiling, have been reported to have caused serious injury to persons in adjoining rooms, Mr. Toch said. To prevent this, lead which is impervious to the rays has been used in metallic form as a sheathing of X-ray rooms; but the metal is heavy and buildings with rooms so equipped require strengthening.

This is not necessary if some compound of barium be used instead of lead, Mr. Toch said, since barium compounds are opaque to X-rays. His method has been either to mix the barium with the wall plaster or to use barium compounds in the wall paint. Either method keeps the rays where they belong, he stated.—[*Science Service.*

HOW TO USE THE LOCAL WATER SUPPLY SYSTEM IN GENERAL SCIENCE INSTRUCTION.[1]

By Earl R. Glenn,
The Lincoln School of Teachers College, Columbia University.

During the summer of 1921, a group of general science teachers at Teachers College held a series of informal meetings for the purpose of developing units of general science instruction that would be based upon the water supply systems of the cities represented by the various teachers in the group. We decided to assemble samples of student work and arrange them in the form of an exhibit which could be sent from school to school for classroom use. The first exhibit of this kind was based on the New York City System. In the meantime, Miss Bessey K. Gish of the East Technical High School of Cleveland, Ohio, and Miss Grace Musch of Muskogee, Oklahoma, prepared similar exhibits for the series.

One of the problems of science teaching is that of developing units of instruction based upon the particular needs of the community. No text-book organization, as such, is a substitute for this type of instruction. On the other hand, it is extremely difficult, because of the necessary expenditure of time and money, for a teacher to make such an organization. The situation is further complicated by the fact that many teachers do not begin such work simply because they do not anticipate a long stay in any one community. If they do make a beginning, they carry their plans with them when they move.

It has seemed advisable to publish some of these preliminary outlines, in order that teachers may see how to begin the organization of local science material. It is probably true that they will be unsatisfactory in certain respects and will require careful revision before further use in the class-room. The formulation of such a preliminary outline is one of the most difficult aspects of the teaching process. With a preliminary plan as a guide it is relatively easy to develop a satisfactory order for teaching the essentials of this unit of the course.

We hope this series of outlines will stimulate other teachers to study their own communities with the idea of making similar organizations of local material. After teaching several classes according to the preliminary outline, it will be possible for the teacher to formulate a plan which will be much more satisfactory from his own point of view.

[1] Read before the Central Association of Science and Mathematics Teachers. General Science Section. Indianapolis meeting, December 1, 1923.

In considering the study of the water system of a very large city like New York, the immensity of the system itself will necessarily call for a thorough study. It is difficult to see how justice can be done to the topic and the pupils if the teacher takes up this unit briefly and as a matter of form only. By this we mean that some teachers may teach the topic merely because it would be bad policy to leave it out. On the other hand, having decided not to leave it out, the teacher may not think it worth while to devote much time to the study of such a topic.

What is more important in the life of an individual than pure drinking water? If we stop to think of the part that pure water plays in the life of every person in the city, we realize that too much time can hardly be given to this unit. We attempt to justify the teaching of various scientific principles by showing their relations to everyday life. How much motivation do we need to interest the pupil in the study of the water supply of his city? An inspirational talk by the teacher will suffice to arouse the pupil's interest in pure water. A field trip, preferably one which will show the general plan of the system, will interest the boy or girl by its magnitude and will spur him on to further investigation.

A series of lessons was outlined for five typical cities. These plans were published in the General Science Quarterly, from time to time, as follows:

City	Teacher	School	Citation in General Science Quarterly
Oakland, Cal.	Anna Lowrey	Joint Union High School, Kingsbury, California	6: 460-77. (Mar. 1922)
Cleveland, Ohio	Bessey K. Gish	East Technical High School	6: 551-67, (May 1922)
Muskogee, Okla.	Grace Musch	West High School	7: 59-68, (Nov. 1922)
Cincinnati, Ohio	Anna H. Raitt	Bloom Junior High School	7: 127-35, (Jan. 1923)
New York, N. Y.	Earl R. Glenn	The Lincoln School of Teachers College	7: 274-97, (May 1923)

We are justified in taking time for this study because of the various scientific principles which are involved. For instance, an opportunity is provided for the study of such principles as

are related to water pressure, gravity, meters, siphons, screws (study of faucets), formation of springs, distillation, filtration, etc. In this way the facts and laws of science are discussed as part of a great scheme. The practical applications are easily seen. Their concrete relationship to everyday life is evident.

All of these outlines, with accompanying samples of student work are now available in the form of an illustrated booklet of seventy-six pages, entitled "Cooperative Work in the Organization of Local Material for General Science Instruction: The Water Supply System," which has been published recently by the Lincoln School of Teachers College.

EVILS OF CIGARETTE SMOKING.

Believing that cigarette smoking is a menace to the physical, mental and spiritual welfare of the young people of America, we reproduce the following clipping from a recent number of *Zion's Herald*, the old and able official organ of one of the largest religious denominations in the United States.

"A report from Washington, D. C., appearing in the daily press a few days ago, said: The American appetite for tobacco continues to turn in the direction of the cigarette, according to figures just made public by the Internal Revenue Bureau, which disclosed that taxes were paid on 5,839,707,747 cigarettes during July, an increase over July of last year of almost 600,000,000. As for cigars, taxes were paid in July on 589,176,020 large and 42,341,000 small ones, the combined total being about 9,000,000 more than the number taxed in July, 1922.

"The increase in the use of tobacco induced by the war, together with the apparent disappearance of a strong witness against it by church and reform agencies, may well cause the thoughtful to pause and consider the question of its increased use in the light of scientific facts. We quote from *The Voice of the Board of Temperance, Prohibition and Public Morals:*

"'Dr. McKeever, well known as a student of adolescents, studied 100 boys, ranging from twelve to twenty years of age, all of whom were smokers. He found that the beat-record of the smoker's heart was similar to that of a very tired person, that it responded to the influence of a smoke for a brief time, but that this inspiring period passed sometimes in less than fifteen minutes. The smoker approximated the heart strength of a non-smoker only immediately after a smoke. In 1897, at Yale, Dr. Seaver made a thorough study of the matter and found that of the 100 highest students five were smokers and ninety-five were abstainers, although of the student body 60 per cent were smokers. Dr. Meylan studied the same problem with the students at Columbia University, and came to the conclusions (1) All scientists are agreed that the use of tobacco by adolescents is injurious; parents, teachers and physicians should strive earnestly to warn youths against its use. (2) It has been shown conclusively by this study that the use of tobacco by college students is closely associated with idleness, lack of ambition, lack of application, and low scholarship.'"

WHY STUDY CHEMISTRY?

By Charles E. Munroe,

Professor Emeritus of Chemistry and Dean Emeritus of the School of Graduate Studies, George Washington University, Washington, D. C.

(Note of Transmission by J. Norman Taylor, Washington Preparatory School, Y. M. C. A., Washington, D. C.: With his permission, I transmit to School Science and Mathematics the manuscript of a discourse given by Professor Munroe before my students. I do this with the thought that other teachers and students of chemistry should have the opportunity of sharing with us this talk from one who not only commands the respect of his profession, but also has the affection of all who have the privilege of knowing him—one of Nature's noblemen.)

Chemistry is that branch of physical science which deals with matter in all its forms, its conditions, and its manifestations wherever occurring. Consciously or unconsciously every person is influenced and controlled by matter and the chemical reactions taking place between matter. It is, therefore, a science with which everybody is concerned and it should appeal to and interest every one as a subject of study. Nevertheless I shall make use of the privilege of this first meeting with you to dwell somewhat specifically upon the various reasons why every one should study chemistry and I shall endeavor to set forth some of the many advantages which should accrue to each from doing so.

Chemistry as a study may be pursued

1. For its economic value; that is as furnishing a means of livelihood. Although this is the least worthy motive I mention it first as it is often a most active determining motive for the pursuit of this study since the majority are compelled to earn their bread by labor. As examples of the opportunities which this profession affords I may note that today chemists are employed not only as teachers and as commercial analysts and assayers but also as analysts, investigators and superintendents in works where acids, alkalies and salts are made; in explosives factories; in metallurgical works (especially about blast furnaces, for iron, and smelters, for copper, lead, tin, zinc and other metals) steel works, and refineries where the commoner metals are refined and the precious metals recovered; in dye works; paper works; gas works; in soap works; in fertilizer works; oil refineries; at agricultural experiment stations; in pharmaceutical works; as assayers in the mints of the United States and with individuals and corporations engaged in isolating the precious metals; as analysts to the great railroads which traverse our territory; as inspectors for the Army and Navy; as associates with physicians

in determining the character and extent of disease in their patients; as associates of State and city Boards of Health; as inspectors of the materials used in buildings and roadways for many of our large cities, and in a great number of other ways too numerous to mention. From the returns of the U. S. Census for 1900, when the last canvas of this kind was made, there were 8,847 persons practicing in the U. S. as chemists, assayers and metallurgists. It is probably not far wide of the mark to assert that there are more than 25,000 chemists usefully employed in the United States today and the advantage which follows their employment has been made so obvious that the demand is constantly increasing.

A special reason for this lies in the active competition for trade which is going on within and without our country, for it has been proven that to successfully manufacture any article dependent on chemical change the operations must be carried on under strict chemical supervision. Take the iron and steel industry as an example. Originally and until recently the iron was extracted from its ores and converted into steel in a wholly empirical manner with the result that the product was of a most variable character, the waste at all points was great, and accidents, which often involved great losses, were frequent. Today no wise man would expect to reach commercial success in this industry unless he employed a corps of chemists to chemically supervise the operations and to test the materials at every step in the process. For instance analyses are made of the ore, the fuel, and the flux, which go into the blast furnace and of the iron, the slag and the gases that come from it; at the convertor, or open hearth, the spiegel iron, or ferro-manganese, which is added to the molten iron is analyzed and likewise, the first step, after the blow is completed, or the melt is "brought to nature," is to take a sample of the product to the chemist to be tested before working it to shape. As proof of the importance of all this we have the statement of Mr. Carnegie to the effect that he owed his success in the steel manufacture, and the enormous fortune that he accumulated, largely to the fact that he was one of the first steel manufacturers to employ a corps of chemists in his works. It is of interest to note too that in the published biographies of the two young men who successively rose to the important position of president of the U. S. Steel Company it is stated that they studied chemistry to fit them for especial usefulness in their various duties, and I do not recall that any other subject of study was mentioned.

The cultivation of chemistry from this standpoint has been given an especial impetus by the immense strides which Germany made in the industrial field through which her manufacturers succeeded in capturing the trade of the world for many products. This progress was such as to cause grave concern in France, the United States, and especially in England. Numerous conferences were held and investigations made regarding the sources of her success, since, as she enjoyed no special advantages of location, cheap transportation, cheap food, cheap fuel or cheap raw material, except potassium salts, these were not readily apparent, and they were found to be due largely to the fact that she was employing trained scientific men, and especially chemists, to a much larger extent in her manufacturing enterprises than obtained elsewhere in the world, and that by this she surmounted her disadvantages. As an example of the unparalled extent to which this employment of specially trained scientific men was carried we find our Consul at Chemnitz to state that in one German factory, the Badische Anilin and Soda Fabrik, 450 chemists, university trained men, were working under the direction of the famous chemist Bernthsen, and that thirty-nine of them were engaged in Dr. Bernthsen's special research laboratory. One-fifth of this corps of chemists attended to the routine analytical work of this one concern, while the remainder prosecuted researches along the lines of manufacture. According to Baskerville,[1] in 1900, the salaries of these chemists, excluding the chief, varied from $1,000 to $5,000 each a year.

In discussing this issue and referring to one of these factories Sir Henry Roscoe[2] said "one chemist was employed at $5,000 a year, who worked for several years without producing any results but eventually through his researches he made a discovery which repaid the firm ten times over and gave them control of an entirely new branch of manufacture."

These citations indicate an additional economic advantage which the study of chemistry affords, for the knowledge thus acquired enables one to increase the quantity, or improve the quality, or cheapen the cost in manufacturing.

As illustrating to some extent the opportunity for this application of chemical knowledge permit me to cite statistics from the U. S. Census of 1909. For several of the recent censuses it has fallen to my lot to collate and discuss the statistics of the so-called Chemical Industries. This category as set forth in Census

[1] Chemical Economics pg. 8; 1900.
[2] J. Soc. Chem. Ind. 16, 570; 1897.

classification relates only to such substances as are styled chemicals in market reports yet the product for these articles alone at the Census of 1909 amounted in value to $424,941,000. But chemists classify as chemicals in their chemical technologies all substances which are produced by a chemical change or reaction, therefore we may also properly include under this heading the following articles of manufacture:

VALUE OF ADDITIONAL CHEMICAL PRODUCTS AT U. S. CENSUS OF 1909.

Iron and steel from blast furnaces and steel works	$1,377,152,000
Other metals from smelters and refineries	604,030,000
Liquors and beverages	488,841,000
Chemicals and allied products	424,084,000
Bread and bakery products	396,865,000
Sugars	376,160,000
Products of petroleum refining	236,998,000
Alloys	169,757,000
Illuminating gas	166,814,000
Patent medicines and compounds	141,942,000
Soap	111,358,000
Manufactured fuels, charcoal and coke	95,880,000
Glass	92,095,000
Dyeing and finishing textiles	83,556,000
Turpentine and rosin	25,295.000
Lime	17,952.000
Blacking, cleansing and polishing preparations	14,769,000
Glue	13,718,000
Ink, printing and writing	11,370,000
Salt	11,328,000
Total	$4,859,964,000

But even this enumeration and amount does not by any means represent the limit for there is not any industry of all those producing the $20,672,052,000 of products sent forth from our factories and workshops in 1909 that could not be advantageously subjected to chemical supervision. Today our architects and engineers are purchasing their supplies on chemical and physical specifications and this custom is extending to all well conducted industries. More than fifty years ago German banks employed expert chemists to investigate and appraise industries seeking loans and within the past few years our own banks have begun to do likewise. I expect that the time is not far distant when even the large retail stores will make their purchases subject to chemical and scientific supervision. In my investigation of the chemical industries I have made inquiries into the existing practice as regards the employment of chemists and found in 1900 that we by no means approached Germany, especially as regards the employment of research chemists. But a gratifying improvement has taken place in the intervening years. Yet if we are to meet competition our manufacturers

must adopt this practice still more widely and I believe that they surely will.

Another means by which we may gain some idea of the large possibilities which industrial chemistry offers to the intelligent industrious and trained man is by viewing this chart which is the original of that published with my address to the American Institute of Chemical Engineers on the Chemical Industries of America in 1909. To produce this chart there have been located on a map of the United States all of the establishments engaged at the census of 1904 in the manufacture of three of the most fundamental and most widely practised of the chemical industries, sulphuric acid, (green squares), explosives, (red circles), wood distillation products, (black triangles), and it is amazing to see how large an area of our country still awaits the coming of the chemist to bring it to fruitfulness. Should you desire a more extended view of the growth of chemical industries I commend to your attention the admirable reports on the Chemical Industries of Denmark, Holland, Norway, and Sweden rendered by Thomas H. Norton, Ph. D., U. S. Consul at Chemnitz, to the Bureau of Manufactures. They are thought so highly of that not only have they been republished in many journals but they have been translated into the foreign languages for publication in book form.

It may be proper here to call your attention to a note of warning regarding the consequences of this striving for knowledge to apply to the solution of material problems which was sounded by Price Collier when writing in 1913 in commenting on the tales of suicide and despair of school-boys in Germany he says:

"It is to be remembered that not to reach a certain standard here means that a man's way is barred from the army and navy, civil service, diplomatic or consular service; from social life, in short. The uneducated man of position in Germany does not exist, cannot exist. This is, therefore, no phantom, but a real terror. The man of twenty-five who has not won an education and a degree faces a blank wall barring his entrance anywhere; and even when, weaponed with the necessary academic passport, he is permitted to enter, he meets with an appalling competition, which has peopled Germany with educated inefficients who must work for next to nothing, and who keep down the level of the earnings of the rest because there is an army of candidates for every vacant position. On the other hand, the industries of Germany have bounded ahead, because the army of chemists

and physicists of patience, training, and ability, who work for small salaries provide them with new and better weapons than their rivals.

"There are two sides to this question of fine-tooth-comb education. Its advantages both America and England are seeing every day in these stout rivals of ours; but its disadvantages are not to be concealed, and are perhaps doing an undermining work that will be more apparent in the future than now it is. The very fact that an alien, an oriental race, the Jews, have taken so disproportionate a share of the cream of German prosperity, and have turned this technical prowess to purposes of their own, is, in and of itself, a sure sign that there may be an educated proletariat working slavishly for masters whom, with all their learning and all their mental discipline, they cannot force to abdicate."

2. The study of chemistry enlarges one's vocabulary.

In the endeavor to describe the enormous number of different kinds of matter, which exist in Nature or may be produced in art, through their several properties and gradation of properties and through the transformations they may be made to undergo and the phenomena in which they may take part, a large number of terms are employed, and to convey or record this information accurately these terms must not only be used with precision but in such a manner and with such qualifications as to set forth all shades of gradations of properties and every degree of variation of phenomena. At the outset there must be an agreement as to the meaning a term or phrase is to possess and it must henceforth be always used with this conventional meaning. As a consequence this science possesses and uses a very extensive vocabulary, while practice in its methods of statement leads to a more exact use of terms and therefore to clearer thinking and more lucid methods of expression. Apart from the general benefit which results from this increased fund of information and this extension of one's vocabulary it has repeatedly occurred in my experience with students that this has frequently been of direct special benefit. Thus since those seeking the bachelor's degree in Science at the University were required to satisfactorily complete certain work in Chemistry many persons who possessed no natural aptitude or inclination for the study were reluctantly compelled to fulfill these requirements. Often I have heard complaints of the hardships that this entailed and queries as to the mysterious reasons which led to this infliction. Yet in re-

peated instances, students of this class have come to me a year or several years later and said, "I cannot tell you how glad I am that I was required to take the course in chemistry. It seemed to me perfectly dreadful at the time and I never could understand why my degree was made dependent upon it, or what earthly use it ever could be to me, but I have just received an appointment (or it may be a promotion in office) because I had taken this course and understood something of chemical signs, symbols and terms and the methods of expression used in chemistry." Many of these persons were women and in no case was the office secured that of a chemist, yet it was the possession of this information which determined the selection of these persons from among others possessing the other qualifications necessary for the performance of the duties of the new office.

(3) The study of chemistry is of value too as a means of culture, for it greatly widens our mental horizon and it makes the invisible apparent to our senses. Being an experimental science it develops the powers of observation. In qualitative chemical analysis we have an example of the severest system of logic; a system in which we are required not only to prove the positive but also the negative. In chemistry, too, we find some of the best opportunities for the application of mathematics and as the quantitative determinations of factors increase in precision and number the use of more and more abstruse mathematics in the solution of its problems becomes possible. It cultivates neatness, order, repose of manner and mental poise, for unless these qualities are exercised in experimental work the results will be of little or no value. In an experience in teaching chemistry, covering fifty years and dealing with several thousand students, I have been especially impressed by this. In fact, I know of no better training for the development of executive ability, though I have spent eighteen years of my life in institutions for educating officers for our Navy and am thoroughly familiar with the military methods that are regarded as ideal in this respect. For in the first place laboratory work, and especially qualitative analysis, is a constant drill. Second, to succeed, before you begin your work, you must thoroughly understand what you seek to accomplish and you must plan your work in advance with that end in view. Third, you must pursue your work in a thoroughly systematic manner. Fourth, you must give your entire attention to the work in hand—you must concentrate. Fifth, all your senses must be at command, they must be alert to observe

and note any phenomena that may occur. Sixth, you must go about your work calmly and keep cool and unperturbed that you may observe accurately. (I know of no circumstances under which the old maxim, "Make haste, less speed," so truly holds as in this pursuit,) and seventh you must cultivate that most valuable habit of making records "at the time"—that is of taking original notes "on the spot."

Many notable instances of men trained in chemistry being called to high executive office may be mentioned. Among them are the two presidents of the U. S. Steel Co. already mentioned. Presidents Eliot of Harvard, Crafts and Noyes of the Mass. Inst. of Technology, Remsen of Johns Hopkins, Drown of Lehigh, Venable of the University of North Carolina, Smith of the University of Pennsylvania, were all eminent chemists. At the same time, the positions of Minister of Foreign Affairs of France and of Prime Minister of England (the two highest executives in these two foremost of nations) were held by chemists. The first by Berthelot, a chemist by vocation; the second by Lord Salisbury, a chemist by avocation.

On the other hand I have found that men possessing marked executive ability, either native or developed by training, such as the military training alluded to above, easily achieve success in routine laboratory work, and (when broadened by cultivation) in experimental investigation. It is noticeable that they go about their work without fuss. They listen attentively and intelligently to verbal instructions and read the printed ones as they would an order from the officer in command. And they give the work in hand their entire attention, with the consequence that they reach the result surely and speedily.

(4) The study of chemistry is worth pursuing since it supplies one with the means for improving the condition of mankind by ameliorating his environment. This in itself supplies an incentive to its pursuit which is most praiseworthy. As examples of this application we may cite the work of Mrs. Richards of Boston and the women who were associated with her in the solving of most perplexing domestic problems by its aid and in pointing the way to more correct living; the work of the chemists of the Boards of Health who are tracing the sources of pollution of air, water and food so that these sources may be diverted; the work of Atwater and Chittenden on the metabolic processes going on in digestion and of Wiley on the effect of food preservatives; the work of the agriculture chemists by which the fertility of the soil

has been notably increased and the conditions of rural industries greatly improved; the work of the organic chemists through which new remedies of great benefit to mankind have been discovered; the work of the physical chemist, like Mme. Curie, by which marvelous sources of energy are disclosed, and the work of the physiological chemists by whose aid the character and extent of the diseases which ravage the human body are being ascertained with a high degree of certainty and the proper remedies indicated. Yet those are but a very, very few of the notable instances in which chemistry is applied to the relief of man.

(5) Chemistry must concern all not only because we are completely subject to its laws and our lives depend for every moment of our existence upon the orderly progress of the many chemical reactions going on within and throughout our bodies, but also because every commercial transaction in which we take part, except barter, is based upon a chemical analysis. This may probably be the most surprising to you of the many statements made to you in the course of these remarks, yet such is the case.

(6) One may study chemistry from patriotic motives, hoping to serve the nation's needs, both in peace and in war. The World War, which doomed mankind to almost unbelievable suffering, taught much—and especially the immense importance of chemistry. We have heard this last war spoken of as a "Chemical War," and so it was. It was a war of explosives, poison gases, metals, fuels, and innumerable other substances having their origin in chemical independence. And, as I pointed out in the address to the American Institute of Chemical Engineers in 1909, independence of nations involves chemical independence. There is nothing new in this statement, however, History records the bitter needs of nations in great distress from lack of chemical preparedness. Dr. Haller, of France, in his address on the "French Chemical Industry during the War"[3] reviewed the tremendous achievements in building up the chemical industry in that country which were necessary for national defense and pictured the almost superhuman labors necessary to accomplish them. Thus in 1914, France faced the same condition of unpreparedness which obtained in 1797 when it was sorely beset by enemies without and within. Today we are attempting to impress upon our own country this same need for preparedness.

Finally, we may study chemistry in the light of progress with

[3]Bulletin de la Société D'Encouragement pour L'Industrie Nationale, 132, No. 6, pp. 761-825.

the purpose of handing down to succeeding generations our inheritance together with our own contributions, ever remembering that progress is made by beginning where our predecessors left off. I was especially impressed with this trust while reading, not long ago, Professor Keyser's address to the Phi Beta Kappa Society in which he refers to Count Korzybski's recently published book, "The Manhood of Humanity; the Science and Art of Human Engineering." Man is given a new place in biological classification. Man possesses a gift not given to plants and animals—that of initiating and continuing the movement of civilization. Permit me to quote excerpts from Professor Keyser's remarkable address.

"Plants * * * take in, chemically transform, organize and appropriate the basic energies of sun, soil and air; but they have not the *autonomous* power to move about in space; together they constitute the lowest order or class or type or dimension of life." They are "the basic—energy-binding, or chemistry-binding, class of life. * * * Like the plants, animals, too, take in, transform, organize and appropriate the energies of sun, soil and air, though in large part they take them already prepared by the plants; but unlike the plants, animals possess the *autonomous* power to move about in space—to creep or crawl or swim or run or fly; it is thus evident that, compared with plants, animals belong to a higher type or dimension of life; * * * because they are distinguished by their *autonomous* power to move, to abandon one place and occupy another and so to appropriate the natural fruits of many localities, the animals are called space-binders—the space-binding class of life."

Human beings also have this power but in addition they possess the power of uniting the Past with the Future by means of the Present. "Because this capacity for binding time, under a law of ever increasing amelioration, is *peculiar* to man or is at all events his in an incomparable degree, the class of human beings is to be conceived and scientifically defined to be the time-binding class of life. We have here * * * a new dimension, a new type of life—life-in-time. Animals are binders of space; man is a time-binder. * * * Such then is the new conception of man—the conception of a being whose character and appropriate dignity consist in his peculiar capacity or power for binding time * * *. Though we human beings are indeed not a species of animal; we are *natural* beings: it is as natural for us to bind time as it is natural for fishes to swim or birds to fly.

"That fact is fundamental. Another one, also fundamental, is this: time-binding power—the characteristic of humanity—is not an effect of civilization but is its cause; it is not civilized energy, it is the energy that *civilizes;* it is not produced by wealth, whether material or spiritual, but is the source and creator of both. Inasmuch as time-binding is the characteristic of humanity, to study and understand man is to study and understand the nature of his time-binding energies; the laws of human nature are the natural laws of these energies; to discover these laws is a task of supreme importance for it is evident that upon the natural laws of time-binding must be based the future science and art of human life and human welfare.

"One of the laws we already know * * * is the natural law of progress in time-binding, or civilization-building. Let us glance at it. Each generation of (say) beavers begins where the preceding generation began; that is a law for animals—there is no advancement, no time-binding—a beaver dam is a beaver dam. Contrast this with human life. Man invests and discovers and creates. An invention or discovery or creation once achieved, what happens? Each invention leads to new inventions, each discovery to new discoveries, each creation to new creations; invention breeds invention, science begets science, the children of knowledge and art and wisdom produce their kind in larger and larger families; each generation begins, not where its predecessor began, but where it ended; things done become instruments for the doing of better things; the Past survives in the living achievements of the dead; the body of these achievements —invention, science, art, wisdom—is the living capital of the ever passing Present, inherited to be held in trust for enlargement and for transmission to future man. The process is that of time-binding; Past and Future are thus united in one eternal Now owning a law of perpetual growth and continual progress."

I may say then, in conclusion, that this new concept offers the greatest reason for studying chemistry—to be of the number who shall pass on to the coming generations that which was their heritage and with much added thereto.

BIOLOGICAL COURSES SPONSORED BY CASS TECHNICAL HIGH SCHOOL SCIENCE GROUP[1]

By Clara E. Bailey,

Cass Technical High School, Detroit.

The formation of an adequate conception of the work of the Biology Department practically demands the brief presentation of the organization of the Science Group since in all except the Clinical Technique Curriculum biological courses may be regarded as related subjects.

The Biology Department forms one unit of what is known as the Science Group headed by John C. Moore. This group sponsors the following six courses which meet the requirements of the academic high school and in addition stress the sciences:

1. Science I which is intended for students who are planning to attend a college of Engineering.
2. Science II for students wishing to prepare for college in medicine or dentistry or to become laboratory technicians or dietetians.
3. Pre-Pharmacy.
4. Industrial Chemistry.
5. Metallurgical.
6. Pre-Nursing.

The science work is being extended to include one or two years of post graduate work for students in pharmacy, dietetics, clinical laboratory technique, industrial chemistry, and metallurgy. This extension is in keeping with the growing tendency among cities to offer a year or more of college training in connection with high school courses.

Each curriculum provides for progressive development throughout the period of training in health, English, mathematics and the social sciences. These are regarded as the *core subjects* essential to the development of personal and social efficiency. Elective subjects have been selected and the six curricula formulated so that the student may choose and prepare for a definite vocation. The term, vocation is to be interpreted in the broad sense so that it may include college preparatory courses.

In the formulation of the various curricula and their revision, various industrial organizations and professional men have been consulted. Each line of work has developed in response to a direct need. For example, when the College of Pharmacy was under consideration the curricula of seventy-five pharmacy schools were studied and from this assortment a curriculum worked out which it was thought would most adequately meet the students' needs. The curriculum was submitted to a com-

[1]Read before the Biology Section, C. A. S. and M. T., at Indianapolis, Ind., November 30, 1923.

mittee of retail pharmacists representing the Detroit Retail Druggist Association, the local branch of the American Pharmaceutical Association and the Michigan Pharmaceutical Association. As a result the Pharmacy Curriculum stresses the subjects especially suited to the needs of men entering the retail drug field and at the same time meets the requirements laid down by the American Conference of Pharmaceutical Faculties. Physiology and Anatomy, Botany, Bacteriology, and Microscopic Analysis form the biological content of the College of Pharmacy Curriculum.

Likewise the Clinical Laboratory Technique Curriculum was submitted to a committee composed of members of the Wayne County Medical Society and Nurses' Committee.

The biological department of Cass Technical High has been attempting to solve the problem of enriched curricula during its three and one-half years of existence. This has involved reconstruction of objectives, development of several courses of study to meet the requirements of the various curricula, formulation of the Clinical Laboratory Technique curriculum, and the furnishing and equipping of the five recitation rooms and five laboratories which are assigned as follows:

1. Biology I and College Botany.
2. Biology I and Physiology and Anatomy.
3. Biology II.
4. Bacteriology.
5. Clinical Laboratory Technique.

The equipment when completed will be modern and adequate for all necessary experimental purposes. Each of the five units according to needs are supplied with water, gas, electricity, compressed air, vacuum and equipment as follows:

a. General Equipment such as aquaria, demonstration microscopes, refrigerator, sterilizers, incubators, centrifuges, etc.

b. Twenty-four units of student's general equipment such as compound microscopes, dissecting microscopes, microscope lamps, double boilers, dissecting trays, ring stands, burette clamps, etc.

c. Individual student equipment sufficient for all experimental purposes which is assigned to student at beginning and checked in at close of semester.

In all of the biological courses at least one-half of the students' time is spent in the laboratory solving practical problems and acquiring a technique helpful in later courses or in their chosen vocations. The class room work consists of lectures, reports on chosen or assigned readings, and class discussions. Frequent use is made of charts, models, museum specimens, prepared microscopic mounts, lantern slides, films, and demonstration experiments. Visits to factories, health board laboratories, and

industrial plants form an integral part of some of our courses.

The vocational subjects in the various curricula serve a diagnostic function. The work of the first and second years of the six curricula is very similar. During this period the students scientifically inclined have opportunity to visit laboratories, talk with older students and instructors and to determine in which of the related callings they may find the greatest opportunity for service. Their training is not intended to result in finished workers. The content of each curriculum results in the students becoming acquainted with materials and the technique of attacking problems when they enter into the pursuit of their chosen vocations and furnishes an excellent foundation for more rapid later progress in either industrial or collegiate work.

We consider the work of the Science group of Cass Technical High as past the experimental stage. Of the 2,500 Science students enrolled in the various curricula sponsored by the Science Group five hundred, fourteen at the present time are pursuing some Biological Course.

Our courses of study are the joint product of all the members of the department. The instructors have participated in their revision as well as formulation to such a degree that all feel the responsibility in carrying them out. We have adopted the policy of gradual rather than abrupt or wholesale revision. The use of mimeographed sheets for laboratory directions make it possible to readily modify any unit of the work to meet changing conditions or the needs of various groups.

In the development of our biology courses we have tried to veer away from the formal logical organization of former years toward a more vital but scientific, interpretation of daily life and at the same time to furnish the opportunity for the student to gain sufficient detailed technical knowledge to aid him in the interpretation of later courses or experiences to be encountered. In other words we feel that some progress has been made and that future revisions will make our courses contribute still more to the seven main objectives of education since we realize that "Education is life itself—not a mere preparation for life."

As S. A. Courtis, Director of Instruction, Detroit Public Schools, says, "We live in a transition age, a time of storm and stress." His slogans "Vitalization and socialization" are being gradually adopted. In many courses certain units of the work are being carried on by groups, and committees and much individual choice is exercised. It is interesting to observe the amount of self direction and self control develop under student

leadership when the teacher retires into the background and assists only in the forming and achieving of their purposes.

The time allotted to this paper limits the discussion of each biological course, however, I shall endeavor to give you some conception of each in that which remains:

(a) Biology is required in the first or second year of each of the seven curricula as an introduction to science and as a foundation for later biological and pharmaceutical courses. In each course the general fundamental biological principles are emphasized but the special needs of the various groups, Science, Pharmacy, Nursing, Dietetics, and Industrial Art, largely determine the choice of subject matter and laboratory materials.

(b) Physiology and Anatomy is required in the third year of the Pre-nursing curriculum. The course is designed to familiarize the student with the structure and function of the various systems of the normal human body and should form a background for interpretation of lectures connected with the nurse's training after she affiliates with a hospital.

For the college students of Pharmacy the lectures in Physiology and Anatomy deal primarily with the main organs and systems of special interest to the pharmacist. The general principles of physiology and hygiene are considered and structure is emphasized only as it relates to function. The laboratory work includes physiological experiments performed to demonstrate the activities of the various organs and to illustrate well recognized actions of drugs upon various tissues and organs.

A mammal is dissected and used in the interpretation of human anatomy. This course is also required during the first semester post-graduate work for students in Occupational Therapy and in Clinical Laboratory Technique.

(c) In the College of Pharmacy Botany course attention is given mainly to the seed bearing plants from which the official drugs are derived. In the three lowest groups of plant life emphasis is placed on the five or six species which furnish drugs official in most pharmacopaeias. Above are used so far as possible for laboratory and demonstration purposes. In case the usual type forms are used, special reference is made to roots, stems, seeds, etc., used in Pharmacy and to the active principles upon which their medicinal value depends. The student acquires technique in methods of killing, fixing, embedding, sectioning, staining, mounting, and observing all of which are of considerable service in their later course in Microscopic Analysis.

(d) The course in Bacteriology was introduced in consequence of the increasing importance of the lower organisms in the various industries, their effect upon the health, happiness, and prosperity of the people and the effectiveness of the present use of biological products as immunizing agents.

Four years ago its introduction into high school curricula was regarded as an innovation, however it is past the experimental stage so far as we are concerned for at present 100 students are enrolled. This number includes the day, evening and continuation courses. General Courses have been outlined for the Science I and Science II students and more specialized courses for the Pre-pharmacy and Pre-nursing groups. Next semester this subject will be offered sixteen clock hours per week to our second year College of Pharmacy students and as soon as a sufficient number of fifth year Industrial Chemistry students demand our attention the general course will be modified to fit their special needs.

The general course is designed to make the student familiar with laboratory methods and technique and to enable him to gain a general knowledge of the relationship between micro and other organisms and the part they play in many important processes. Particular attention is given to the significance of micro-organisms in decomposition of organic materials resulting in harmless, desirable or injurious products; to the effect of bacterial deteriorated substances in the body; to their importance in agriculture and the industries, and to the methods of food preservation. The student learns the methods of handling, cultivating, isolating, identifying, staining and of studying non-pathogenic bacteria, yeasts and molds. Special attention is given to the principles involved and the effectiveness of various disinfectants and antiseptics. The physical means of sterilization are also used and emphasized. The course also involves the application of the Bacteriological methods of milk, food, water, and sewage analysis with interpretation of results. Purification of water, methods of sewage disposal, production of immunizing agents and the control of the more prevalent pathogenic organisms are considered.

The course in Pharmaceutical Bacteriology is designed to give the student a general knowledge of laboratory methods and technique, of the significance of micro-organisms in pharmaceutical practice, and of the cause of the more common bacterial and protozoan diseases and their control. Special attention

is given to the significance of micro-organisms in the decomposition of organic materials resulting in harmless, desirable, or injurious products; to the effect of bacterial deteriorated substances in the body; to disinfectants, their preparation and use; to the source, production, preparation, and use of the various commercial immunizing agents; and to the storage and care of biological products.

(e) Last September the Clinical Laboratory Technique Curriculum sponsored by the Biological department was introduced. The newly equipped laboratory provides every facility for training in modern methods of making various clinical tests and examinations connected with blood analysis; urine analysis; gastric analysis; examination of sputum, pus, feces, spinal fluid; blood chemistry; and serology.

NEW DEVICE RECORDS KICK OF IRON HORSE.

Railroad officials, representing a majority of the leading railroads of the country, who went to Erie, Pennsylvania, to witness a demonstration of new types of electric locomotives and were thrilled to see one of the powerful Mikado type steam locomotives pulled backwards in a spectacular tug-of-war by an electric giant, and to see another type of electric locomotive glide over the rails at 105 miles an hour, found great interest in another device known as the otheograph, which accurately measures the stress or action on the rails of each separate wheel of a locomotive or motor car.

This new instrument, as explained by A. F. Batchelder, designing railway engineer of the General Electric Company, shows by a graphic chart the extent and characteristic of both the vertical and sideways thrust of all the wheels on each rail. The vertical weight is carried by heavy springs underneath the rail and the sideways thrust is carried through similar springs set vertically and bearing against the head of the rail. The deflection of these springs on the passage of the locomotive is recorded through a lever having an 8 to 1 ratio, with a pointer at the end which traces a record on paper wrapped around a rotating cylinder.

The otheograph ties may be installed in place of the regular ties, either singly or several grouped together, and on curves or straight tracks. The present installation at Erie comprises 25 of these ties grouped together covering a distance of fifty feet of straight track. The revolving mechanism provides for moving all of the recording cylinders on each side of the track simultaneously so that as many records may be taken of each side of the locomotive as the number of ties that are grouped together. The movement of the operating mechanism for the recording cylinders is independent of the speed of the locomotive.

The record from a slowly moving locomotive shows the equalized distribution of the weight, and such a record serves as the basis for comparison with a record taken at high speed. The effect of side thrust in changing the vertical component, and any variations due to dynamic unbalance, are quite noticeable. The effect of a wheel with a flat spot shows very clearly. The record is not necessarily limited to that of a locomotive only, as by moving the paper slowly the record of all wheels of an entire train of a hundred or more cars may be taken.—[*Science Service.*

A PLEA FOR MORE OUTDOOR SCIENCE TEACHING[1]

By E. L. Moseley,

State Normal College, Bowling Green, Ohio.

Outdoor life is natural, pleasurable, and healthful. For many thousands of generations our ancestors have lived in the open. It is contrary to all previous experience of the race and therefore is unnatural for young human beings to be shut up for the major part of the time that the sun is shining. Students of all ages welcome every opportunity to get outside in fine weather. Those who are quick to learn and those who are studious, as well as the dull and indolent, prefer some outdoor instruction to spending the usual amount of time in the school room. In after years they recall this part of the work with the greatest pleasure and believe that they learned more, as a rule, while outside with their teacher than they learned in the same amount of time while indoors. In his book on Physical Education, Dr. Felix Oswald says: "No domestic events of our later years can efface the impression of the woodland rambles, butterfly hunts, and huckleberry expeditions of our boyhood; the recollections of our first out-door adventures endure like the mountains and rivers of a promised land whose cities have vanished forever."

Of all the many factors upon which health depends no other seems to have such a potent influence as being out of doors. "Out-door life is both a remedy and a preventive of all known disorders of the respiratory organs. It has been repeatedly observed that individuals who attained an extreme old age were generally those whose avocations required daily labor in the open air, though their habits differed in almost every other respect.

The child must see real things before he can form clear mental pictures of the things he reads about. Science instruction given by means of books, recitations and lectures, is of little use without a background of experience in which impressions are made on the senses by the things that are discussed. We recognize this by providing laboratories and lecture table experiments. But many things which children should observe and understand cannot be brought into the school room. The experience of these things gained in a haphazard way is usually meagre and not very enlightening. Nature study is the natural

[1]Read before the General Science Section of the C. A. S. and M. T., Indianapolis, Ind., December 1, 1923.

beginning in education. It represents a genuine interest of children, who in an hour's trip will often see more that they will remember than in a week at school. After an excursion spent in observing things to which their attention is directed, they have something interesting to talk and write about, so that their language exercises proceed more smoothly.

We are beginning to realize that elementary science instruction should be commenced long before the child has reached the high school. His interest in animals and machines is greater than his interest in grammar or arithmetic. It is a serious mistake to defer instruction about the things that surround him until he has spent years in mastering the use of symbols and studying the history of other people and of other lands. He needs to see and to understand the things about him, including many that are not found in the school room.

Outdoor instruction is profitable in connection with each branch of science taught in junior or senior high school, and is even more desirable for children in the elementary schools. The things to be observed depend on local conditions. In most cases the following should receive attention on one or more occasions:—rocks, pebbles, soil, valleys, streams; trees and smaller plants, both wild and cultivated; mammals, whether wild or domesticated, birds, insects and other animals; some of the local industries. Nearly all the schools with the exception of some of those in the large cities are so located that many of these things are within walking distance, and going outside with a class should not be an unusual thing. Occasionally excursions should be taken to places farther away.

School authorities who appreciate the value of outdoor instruction will make it easy for teachers to take their classes outside whenever they deem it advisable. Something worth while may be accomplished in a single period. It is much better to have some double periods available. Where the program does not provide for this, excursions may be made after school or starting at the beginning of the last period in the afternoon. Occasional Saturday excursions are also much appreciated by the students and, if well conducted, are very profitable. In the colleges and universities, excursions involving weeks of time and hundreds or thousands of miles of travel are becoming rather common, and afford a valuable means of instruction.

The difficulty of maintaining discipline among children while outside has been urged as an objection to undertaking

outdoor instruction. Much depends on the attitude of the students. If they have a feeling of antagonism for the teacher, she may find her troubles increased by taking them outside. If on the other hand there is a spirit of comradeship and friendship, the outdoor work will tend to increase the respect of the pupils for the teacher and to bring about a better acquaintance and understanding of each pupil by the teacher. She should not demand of her pupils, when outside, unremitting attention to any subject. Much freedom should be given them, especially on the longer excursions, and close attention be demanded when explanations are being given. Usually the pupils are eager enough to do or observe the things suggested. If something has been said prior to the time of the excursion about the things they are to see, they will examine them with more interest. Their conversation among themselves when the teacher does not require their attention should be mainly about the things they have been observing. On excursions that last for several hours, it is perhaps unreasonable to expect that more than half the time will be given to consideration of anything the teacher has had in mind. Incidentally they will learn useful things she had not thought about. Besides the teacher conducting the excursion, other teachers from the same school often accompany them and are willing to take some responsibility for looking after the students.

The only serious obstacle to more outdoor instruction is the lack of properly trained teachers. Teachers, like other people, dislike to display their ignorance. They can keep up with book assignments so as to feel prepared to answer most of the questions that may be asked, but nature study opens a field so large that the teacher's knowledge goes but a little ways. If the teacher takes the attitude toward learning which everyone should take—that of really wanting to know the nature of things or how they have been formed, or, if artificial, what they are used for, and how they work—she will not find it difficult to instill the same spirit in her pupils; then teacher and pupils will take pleasure in investigating things together.

Incompetent teachers are less numerous than in former years. We are now requiring a longer course of training for the elementary teacher. Beginning with the present year at the Normal College of Northwestern Ohio the candidate for a diploma in elementary education, except in special courses, is required to take either nature study or agriculture. This will prevent her from undertaking to teach without any knowledge of things out of doors.

Every intelligent person would be interested and benefited by gaining first-hand knowledge of the sources of supply of drinking water, of food and the various building and clothing materials. Yet a large part of our population have never had an opportunity to visit, under intelligent guidance, the establishments where most of these things are obtained or produced. Some of the places that may well be visited by classes are the following: public water supply, so as to see the source of the water, the reservoir, pumping station, filtration or sterilization plant and the stand pipe; ice plant, creamery or pasteurization plant, cannery, flour mill, saw mill, wood-working shop, blast furnace or foundry, metal-working shop, power house, dwelling house or other buildings in process of construction, quarry, lime kiln, cement mill, glass factory, pottery, textile mill.

Not all of these are to be found in one neighborhood, perhaps only half of them could be reached without much expense. Whatever industries are important in the neighborhood should be the subjects of study by the school children at some time in their course. Usually the manager or superintendent willingly explains many details to visiting classes or sends some well-informed assistant to do so.

Both town and country classes would profit by witnessing together various operations to be seen in rural districts, and having explanations given by those who have assisted in these operations. Demonstrations by agricultural agents have proved of great use to the farmers. The farmer's child would get ideas that might be adopted at home, if he were to visit, under intelligent leadership, farms where different crops are cultivated or different methods used.

Many children are permitted to grow up without learning to tell even half a dozen kinds of trees, in addition to the common fruit trees. Many are unable to distinguish a cedar from a pine or a poplar from a maple. Is there any excuse for our failure to teach them? Is there any excuse for their inability to recognize a meadowlark, a king bird, a chimney swift, a purple martin or a house wren? Is it more impotrant for the farmer's wife or daughter to know that Ann Boleyn was one of the wives of Henry the Eighth than to know that cabbage worms come from eggs laid by white butterflies or that lady birds eat the eggs of potato beetles or that bats and dragon-flies are not harmful to people but are beneficial, because they catch so many mosquitoes?

A large number of people, when away from home, are unable to tell the directions. When the sun or stars are shining the ability to orient one's self is easily acquired and would be useful to everyone. Ability to interpret the topographic features of the environment is one of the most interesting and profitable of acquisitions and can best be acquired by the child or grown person out-of-doors. Why is this region so level, another so hilly? What made that ridge or this valley? Why are many roads straight and others so crooked?

I know of a small city in which the children in any one of the schools could walk to a good example of a sand dune in a few minutes, but where they have learned of dunes as things to be seen only in some distant region. Is it any wonder that children trained in such schools have little knowledge of the world even after many years of study?

To sum up the leading thoughts of this discussion: we may say that only a few children are fortunate enough to receive from their parents or from associates much instruction in regard to important industries or the things in nature which intelligent people want to know about. Nor does the school afford them much real knowledge of these things, when the instruction is wholly intramural. By taking them outside we provide them with recreation, promote their health and contribute materially to their intellectual progress.

CROP ROTATION AS GOOD AS FERTILIZER.

Crop yields may be increased about as much by the practice of crop rotation without fertilizers as by the use of fertilizers without crop rotation, Dr. Milton Whitney, Chief of the Bureau of Soils of the U. S. Department of Agriculture, told the American Institute of Chemical Engineers in session at Washington. If both crop rotation and the use of fertilizers is practiced, the yields are nearly equal to the sum of the increases obtained by rotation and by fertilizing.

Before the war, Germany was the greatest user of commercial fertilizer, with a consumption of 188 pounds to the acre of land in crops, Dr. Whitney stated. The consumption in this country was 40 pounds to the acre on the average, ranging from practically nothing in the western grain districts to 150 pounds to the acre in Maryland and 345 pounds in Florida. At present the cotton crop west of Alabama is practically unfertilized and the commercial crops of grain and hay are produced without artificial fertilization.

Dr. Whitney said the abandonment of the medieval system of agriculture in England, the development of individual farm holdings, the introduction of crop rotation, fertilization, and better methods of tillage had increased the average yield of wheat in that country from 6 to 32 bushels to the acre in about 700 years.—[*Science Service.*

GENERAL SCIENCE WEIGHED IN THE BALANCE[1]

By Mrs. Viva Dutton Martin,
Arsenal Technical Schools, Indianapolis, Ind.

In the last few years, when so many innovations have appeared in the courses of study, general science among them, a school which has carved out for itself an independent program is of especial interest. Such a school is the Arsenal Technical School of Indianapolis, Indiana. To its five thousand odd students it offers a program of great variety and possibilities.

When the freshman enters, he may choose one of two general courses: vocational or academic and technical, i. e., regular high school work, with special emphasis on technical subjects, including science and mathematics. If he chooses the vocational, he elects one of the ten possible vocational groups. As soon as he makes this election, his course for two years is fixed; he must take certain definite, related courses. When a boy has but two years to train for a vocation, he must take only those subjects which lead very definitely to that end. Among these, general science finds no place, for it trains for no particular end.

If, however, the student wishes to take a four year high school course, he meets with a different situation: his chance for election is, necessarily, much broader. There is grave danger that the student will choose either aimlessly or unwisely, unless he is carefully guarded. The subjects offered for his choice have been worked out with the greatest care in order that the work of his first year may give him the best possible foundation for whatever specialized course he may choose for the subsequent years of his high school course.

English, mathematics (algebra, advanced arithmetic, or commercial arithmetic), language (Latin, French, Spanish, or German), civics, building crafts, mechanical drawing (½ credit) free-hand drawing, clerical practice, clothing, chorus (½ credit), and physical training (½ credit) are the branches from which the student regularly, at the outset, selects four one credit subjects to which he may add one half credit subject. In any case, he is required to take the English and one of the mathematics group; he fills his half credit with mechanical drawing, physical training, or music, as his tendencies direct, and he is left with the selection of two possible subjects.

[1]Read before the General Science Section of the C. A. S. and M. T., Indianapolis, Ind., December 1, 1923.

If the student is inclined to be interested in technical work, he will elect building crafts, free-hand drawing, or clerical practice[2] and if it is a girl, clothing for one of the electives. Civics is practically the only other alternative for the remaining subject, since such a student is not interested in language.

If the student wishes to prepare for college, he will, of course, elect a language, and if such a student is interested in purposeful life training, either free-hand drawing or clothing will be elected to complete the program. If unsettled as to his chosen work, he will naturally take civics.

From the above analysis it becomes obvious that the only possible place for general science in the first year academic program would be in competition with civics. There are two fundamental reasons why general science is not allowed to compete. The first is that the presence of both civics and general science on the program would lead the student to elect both to the necessary exclusion of either a technical or a language subject, which is absolutely essential to the completion of the kind of a course which he wishes eventually and so, in his third or fourth year, he would face a serious complication of program due to lack of required subjects. This is strikingly illustrated in the case of the student who, by the end of his second year decides to elect one of the advanced technical courses[3] (machine drafting, architectural drafting, commercial art, mill work-wood, pattern making, foundry, machine shop, and applied electricity). These are four period, double credit subjects. Only the student who has taken care of graduation requirements and elected no superfluous courses, such as general science, can hope to take these subjects which occupy such a large part of his program for the last two years. The second is that the course in civics is regarded as more profitable in a bigger sense than general science. The course in civics, as now given, aims in two semesters' work to present to the student a cross-section view of society, its complex relations, and the relation and importance to society of the different occupations. In the latter phase, emphasis is laid on the relation of science to industry, so that when a student selects a vocation, he will know in which science he should specialize to best fit him for his chosen work. Such a broad view of life, including the relation of science to it, is regarded as more valuable to the student than the limited

[2]This subject, which must be taken with commercial arithmetic, is offered for those pupils intending to stay in high school but a short time and who wish to get intensive training for some of the many elementary clerical positions.

[3]Open only to Juniors and Seniors.

phase showing the relation of science alone to life as presented by general science.

If there is no place for general science in the first year, why is it not placed in the upper years, where some schools have placed it? There are two reasons: First, it is believed that one complete year in any one branch of science gives the student more valuable knowledge and training than the superficial, diversified course in general science can possibly offer. At best, one year in a science can do little more than give a broad idea of the general field covered by that science and point out the highly specialized fields related thereto. When this is true, what can possibly be done with five or six sciences in one brief year? Second, general science tends to crowd out physiography, which the Technical High School believes is a more valuable science. Physiography is offered on an equal footing with other double period, laboratory sciences. Incidentally, too, general science does not satisfy the college entrance requirements.

For two years, a one semester course in introductory science, supplementing a semester of civics was offered in the freshman year. This course was presented to aid the student in his choice of a vocation. A few figures gathered from the science classes this semester may throw a little light on the success of this course in introductory science. Of 815 pupils now taking science (chemistry, physics, zoology, botany, and physiography) 276 have had introductory science. Only twenty-five per cent of these were influenced in electing the present science because of interest aroused in the introductory science work. Thirty-two per cent admitted that in some small particulars the introductory science had been a help to them in the present science, but they all maintained that the amount of assistance had been so small as to be almost negligible.

By the end of the second year it had become evident that the introductory science was not meeting existing needs and so the course was merged into the second semester of civics in the manner explained previously. Thus general science was weighed in the balance—and found wanting as far as meeting the needs of the Arsenal Technical School was concerned.

DYNAMITING MOSQUITOES.

Man has begun to use high explosives in his war against insects. Dynamite, which we usually think of in connection with the destruction of big things, is now being employed against little mosquitoes. It is used to blast these dangerous disease carrying pests out of existence by digging ditches which drain the mosquito breeding grounds.

A NEW FORM OF BALLISTIC PENDULUM

By Oswald Blackwood.

Assistant Professor of Physics, University of Pittsburgh.

The principle of the conservation of momentum is so important that the omission of all reference to it from many laboratory manuals is worthy of notice. A probable explanation is that the available experiments are unsuited for elementary students.

One of the widely used forms of momentum apparatus is described in Millikan's "Molecular Physics and Heat." In the experiment a lead ball falls down a circular arc and makes inelastic impact with a suspended cylinder. The two then swing through a graduated arc. The vertical rise is determined by the use of trigonometry. While this experiment is admirably adapted for the more advanced students, the writer has found it too complicated for most Freshmen; first because of mathematical difficulties, and second because of an angle correction necessitated by the shift of the position of equilibrium which occurs when the ball is allowed to hang suspended against one of the ends of the cylinder.

Another form of momentum apparatus is the ballistic pendulum which is sometimes used to measure the velocity of a bullet. This experiment appeals to most boys, and both theory and manipulation are relatively simple. The attendant noise and danger, however, make it quite unsuitable to perform in crowded laboratories.

In devising the new form of ballistic pendulum which is to be described, the use of trigonometry has been made unnecessary by providing for the direct measurement of the height of rise after impact. The noise and danger have been eliminated by replacing the fire arm by a catapult or spring gun which discharges a once inch brass ball with a velocity below the danger limit.

The most novel part of the apparatus is the pendulum bob which is a hollow brass cylinder into which the projectile enters and is trapped by a spring (Fig. IA). The purpose of using a hollow cylinder instead of a solid one is to make unnecessary the angle correction mentioned above. This is accomplished by so designing the parts that the center of gravity of the lodged ball is immediately below that of the pendulum proper so that the entrance of the ball does not change the position of equilibrium as it would if it adhered to the end of the cylinder.

Procedure: After compressing the spring and locking it by means of the trigger A (Fig. I) the drilled ball is slipped along the horizontal rod until it rests against the spring. When the trigger is raised the ball is discharged and enters the cylinder which then swings forward to a position D where it is caught and held by pawl E (Fig. I). The elevation above the table of the needle

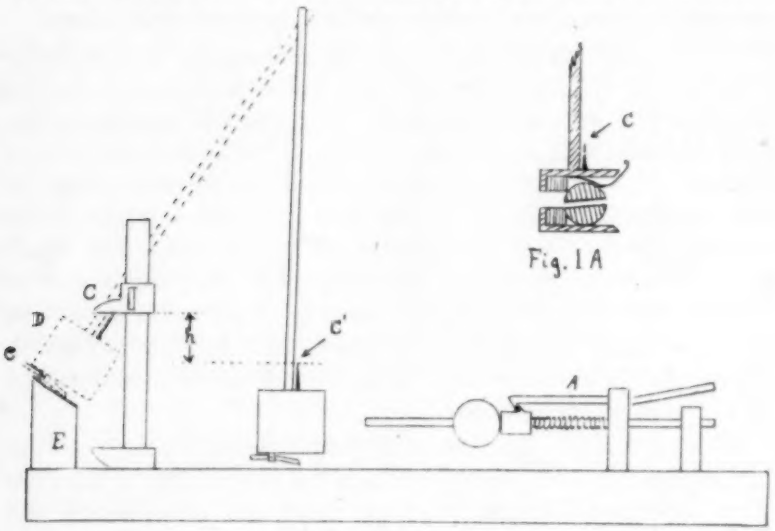

Fig. 1 A

FIG. I

point C (which locates the center of gravity of the swinging system) is measured by means of vernier calipers. A similar measurement is then made with the pendulum hanging freely, and the height of rise h is found by subtraction. The velocity v

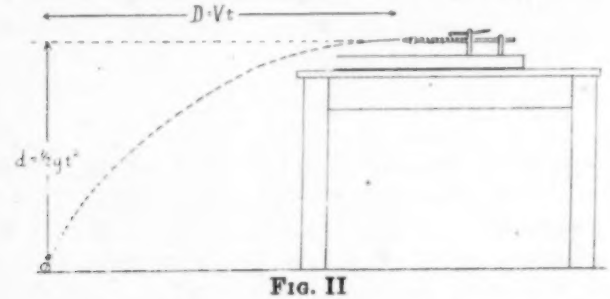

FIG. II

of the system immediately after impact is calculated using the equation $v^2=2gh$. After weighing the ball and the pendulum, the momentum of the suspended system after impact is found and from this value the velocity V of the ball before impact

is computed assuming the conservation of momentum.

As a check determination, the velocity V is also determined in a different and more direct way. After removing the pendulum and the rack E the ball is discharged as before and the point of impact on the laboratory floor is marked. After measuring the vertical and horizontal displacements d and D (Fig. II), the time of flight t is found from $d = 1/2\ gt^2$ and the horizontal component of velocity V from $D = Vt$. The values of V by the two methods agree within three per cent.

While this experiment is sufficiently simple and straight forward to be carried through successfully by most students, the underlying theory, which involves the conservation of energy and the independence of vectors as well as the conservation of momentum, has proved sufficiently difficult to intrigue the interest of our most capable workers. The second part which is a simple case of trajectories has an especial appeal because of the interest in ballistics which the boys have developed in games such as football and baseball.

CONSOLIDATED SCHOOLS.

For eighty years or more educators have known and pointed out that the little one-room school, even at its best, is an ineffective instrument and should exist only where it is impractical to provide anything else, says the Bulletin "Consolidation of Schools and Transportation of Pupils," just issued by the Department of the Interior through the Bureau of Education.

The rural school project of continental United States consists in educating over 18 millions of young people between the ages of 5 and 20 who live in small towns and villages or in the open country. The 300,000 or more schools classified as rural enrolled nearly 12½ millions of pupils in 1920. Two years ago at least one-fourth of the rural school enrollment and 45 per cent of the teaching force were in 187,951 one-room schools, nearly all of these schools being in the open country. A hopeful sign for the future is set forth by the bulletin in the statement that in 1920, 389,783 pupils were enrolled in about 12,000 consolidated schools.

Consolidated schools equalize educational opportunities by concentrating the wealth and energy of large areas, thus securing better teachers, more artistic and adequate school buildings, better attendance, and healthy and happy children. The playgrounds equipped for athletic meets, baseball, basketball, and tennis, the gymnasiums with shower baths and swimming pools, put the children on a par with their city cousins. Consolidated schools may have modern classrooms and heating plants; they may maintain laboratories where science, agriculture, and cooking are taught, and they may have garden plots, small fields, and livestock.

THE TERMINOLOGY OF ELEMENTARY GEOMETRY.

By Louis C. Karpinski and Adelaide M. Fiedler[1]
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The historical development of geometry would lead one to expect a preponderance of Greek terms in the technical vocabulary of geometry. However, the fact is that out of the list of about one hundred common terms comprising the bulk of the technical vocabulary of geometry, over one-half are Latin in origin and only one-quarter are Greek. Equally surprising is the fact that French forms have played a rôle equal to that of the Greek forms in the development of our English vocabulary of geometry.

The ideas of our elementary geometry were developed with remarkable completeness in Greece. The transmission of these ideas to medieval and modern Europe began in a most elementary way with the work of Boethius. Although this writer gave almost no attention to the demonstrative side of geometry yet his definitions and discussions played a great part in fixing the Latin vocabulary of geometry. It should be noted that many terms which have a technical use in demonstrational geometry have also a popular and practical use. Boethius employed, when possible, the Latin term then in current use rather than any adaptation of a Greek term.

Other Latin writers who contributed to the development of a geometrical vocabulary are representatives of the fields of architecture, engineering (aqueducts), and surveying. Prominent among such writers are Vitruvius, flourishing just before the beginning of the Christian era, and Sextus Julius Frontinus of the first century, A. D. Later writers whose work corresponds more closely to that of Boethius are Martianus Capella of the fifth century, Cassiodorus of the sixth and Hrabanus Maurus of the eighth century.

The real presentation of the geometry of Greece to western Europe began with Latin translations from Arabic as well as from Greek, made during the twelfth century. During this period and for some centuries before and after, Latin was the common language of the academic world, a real universal tongue. To this fact alone, and not to any Roman or Latin interest in geometry as a science, is due the presence of so many Latin terms in geometry.

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[1]The introduction is written by Professor Karpinski and the summary has been made by Miss Fiedler.

Just as Latin was the language of European schools for centuries, so in England for a period after the Norman Conquest was French the language of cultured people. In consequence English students of geometry made their acquaintance with the subject through French textbooks. Chaucer and Wiclif, who were most potent in establishing a wider use of English in educated circles, themselves reveal constantly a dependence upon French. Chaucer had a lively interest in mathematical science, evidenced by his treatise on the Astrolabe. In his writings Chaucer employed a large number of technical terms of arithmetic and geometry.

Robert Recorde in the sixteenth century was the author of the first English text on geometry. However, this is not on Euclidean geometry, but rather a practical treatise. The terminology of his geometry was not popular and did not greatly influence subsequent works. On the other hand, Billingsley in his translation of Euclid, published in 1570, did strike the popular note and many of our terms are found in his work. Recorde was rather more fortunate in the vocabulary of his arithmetic and algebra.

The dictionary can be made to furnish stimulating inspiration to pupils studying elementary geometry. The preceding notes and the following summary should serve as a point of departure and also to give the teacher a notion of the development of the vocabulary in its larger outlines.

THE TERMINOLOGY OF ELEMENTARY GEOMETRY.
Summary.

Origin	No.	Greek	Latin	French	O. F. or O. E.	Egyptian	Constructed
Greek	23	2	11	7	1		2
Egyptian	1					1 (?)	
Old French or Old English	12	0	1	4	6		
				Anglo-Fr. 1			
Latin—Classical	33		19	8	6		
Latin—Medieval	16		10	5	1		
Latin—(Constructed)	9			}			9
French (or Latin)	3			[3			
French (Constructed)	1						1
	98	2	41	28	14	1 (?)	12

Greek-Classical.

Word	*Original*	*Through*	*English Use*
apothem	mod. f. Greek αποτυθεναι		In modern Dicts.
axiom	αξιωμα	French—axiome	1600 Hooker J.
base	βασις	French—base	1570 Billingsley
cone	κωνος	French—cône	1570 Billingsley
cube	κυβος	French—cube	1398 Trevisa Barth
cylinder	κυλινδρος	Latin—cylindrus	1570 Billingsley
decagon	δεκαγωνον-ος	Latin—decagon-um	1571 Digges
diameter	διαμετρος	Old French—diametre	1387 Trevisa Higden
hexagon	ἑξαγων-ον	Latin—hexagon-um	1570 Billingsley
hypotenuse	ὑποτεινουσα	Latin—hypotenusa	1571 Digges
hypothesis	ὑποθεσις	Greek—υποθεοις	1596 Earl of Ellis
isosceles	ἰσοσκελης	Latin—isosceles	1734 Builder's Dict.
parallel	παραλληλος	French—parallele	1549 Compl. Scot.
parallelogram	παραλληλοιγραμμον	French—parallelogramme	1570 Billingsley
pentagon	πενταγων-ος	Latin	1570 Billingsley
polygon	πολυγωνον	Latin—polygonum	1571 Digges
prism	πρισμα	Latin—prisma	1570 Billingsley
problem	προβλημα	French—problema	1570 Billingsley
pyramid	πυραμις Probably Egyptian origin. Tropfke says Greeks borrowed the word *pyramide* from Egyptian	Latin—pyramis Possibly from Egyptian pyramide	1572 Billingsley
sphere	σφαιρα	Late Latin—sphera	1398 Trevisa Barth
theorem	θεωρημα	Latin—theorema Perhaps directly from French théoréme	1551 Recorde
trapezoid	τραπεζοειδης	Mod. Latin—trapezoïdes	1706 Phillips

Greek Constructed.

Word	*Original*	*Through*	*English Use*
perigon	Peri (περι-prep) +(γωνια-angle)		1868 Sandeman Pelicotetics
perimeter	περιμετρος from (περι-around) +(μετρον-measure)		1592 R. D. Hypnerotomathia

Old English.

Word	*Original*	*Through*	*English Use*
axis	eax	Latin—axis	1734 Builder's Dict.
circle	circul	French—cercle	1305 Edmund Conf.
edge	Old Aryan		
oeceg:	o s eggia;	O H G ekka—M H G-ecke	Mod. German-ecke;
O N egg—	O.Teut. agjâ		1391 Chaucer
foot (of ⊥)	Common Teutonic		1840 Lardner
line	line	French—ligne	1559 W. Cunningham Cosmogr.
plane	plaine (O. F.)	French—plane	1570—
			1704 J. Harris
proof	preove (M E.)	Old French—preuve	1430 Art Nombryng (Arith.)
proposition	proposicioun (M E.)	French—proposition	1570 Billingsley
right angle	O E recht-richt-rycht;	M D U recht—richt; O S reet	
	O H G-reht; M H G-recht.	Related to Latin rectus	
ruler	represented by O. F. *regle*	O F ruile, reule	1340 Ayenb
side	Common Teutonic		1400-50 Alexander
skew	O F escu	O F escu	1848 Cayley
sum	O. F. summe	A. Anglo—French summe	1430 Art Nombryng
square	O. F. esquarré	O. F. esquarré	1551 Recorde

Latin Classical.

arc	arcum	O. F. arc	1570 Billingsley In Recorde "arch"—1552
area	area	Latin—area	1570 Billingsley
altitude	altitudo	Latin—altitudo	1570 Billingsley
angle	angulus	French—angle	1386 Chaucer
center	centrum	French—centre	1374 Chaucer
circumference	circumferentia	French—circonférence	1393 Gower Conf.
curve	curvus	Latin—curvus	1696 Whiston
dimension	dimension-em	French—dimension	1413 Pilgrim Sowle
distance	distantia	O. F.—destance	1594 Carew
extreme	extremus	O. F.—extreme	1570 Billingsley
exterior	exterior (angulus)	Latin—exterior	1570 Dee.

Boethius uses it only in sense of exterior angle.

Word	*Original*	*Through*	*English Use*
face	altered f. facies	French—face	1625 in Reymer "Foedera"
figure (pertaining to form)	figura	French—figure	1340 Ayenb
lateral	lateralis	Latin—lateralis	1674 S. Jeake
locus	place	Latin—place	1727-41 Chambers Cycl.
median	medianus	Latin—medianus	1888 Hall and Stevens
magnitude	magnitudo	Latin—magnitudo	1570 Billingsley
obtuse	obtusus	Latin—obtusus	1570 Billingsley
perpendicular	perpendicularius	O. F.—perpendicular	1570 Billingsley
point	punctum	French—point	1391 Chaucer
protractor	protractor	Latin—protractor	1658 Phillips
quadrant	quadrans	Latin—quadrans	1571 Digges.
ratio	reri	Latin—reri	1660 Barrow
radius	radius	Latin—radius	1656 Hobbes
scalene	scalenus	Latin—scalenus	1734 Builder's Dict.
sector	sector	Late Latin—sector	1570 Billingsley
segment	segment-um	Latin—segmentum	1570 Billingsley
semicircle	semicirculus	Latin—semicirculus	1526 A. C. Mery Talys.
solid	solidus	O. F.—solide	1495 Trevisa's De R. R.
surface	superficies	Latin—superficies	1658 Phillips
tangent	tangens	Latin—tangens	1594 Blundevil
vertical	verticalis	French—vertical	1704 J. Harris Line—vertical (straight line or plane surface) 1571 Digges. Vertical angle 1794 R. J. Sulivan
volume	volumen	O. F.—volum, volumme	1570 Billingsley
antecedent	antecedent-um	*Latin Medieval.* French—antécédent	1570 Billingsley
acute	acutus	Latin—acutus	1570 Billingsley
compass	compassus	French—compas	1340 Cursor M.
complement	complement-um	Latin—complement-um	1570 Billingsley
chord	chorda	A 16th Cent. refashioning of cord, corde after Latin chorda. Indirectly from	

Word	*Original*	*Through*	*English Use*
		Arabic and Hindu.	
congruence	congruentia	Latin—congruentia	1551 Recorde
corollary	corollarium	Latin—corollarium	1879 Henrici
equivalent	aequivalent-em	Late Latin—aequivalent-em	1374 Chaucer
homologous	homolog-us	Latin—homolog-us	1806 Hutton
horizontal	L. type horizontal-is f. horizon	Latin—horizontalis	1660 Barrow
limit	limit-em	French—limite	1838 Sir T. Herbert
measure	mensura	French—mesure	1727 Newton
median	median-us	Latin—mediān-us	1570 Billingsley
original	original-is	French—original	1888
			Not given in connection with geometry.
postulate	postulat-um	Latin—postulat-um	1660 Barrow
regular (polygon)	originally a. In later use re-adopted from or conformed to Latin original—	Old French—reguler	1665 Phil. Trans. ad. regulāris
secant	secant-em	Latin—secant-em	1595 Blundevil
		Constructed Latin.	
adjacent	f. ad + jacere	Latin—adjacent-em	1430 Lydg. Bochas
bisector	f. bis + sect	Latin—bisect	1684 Reader
circumscribe	f. circum + scribere	Latin—circumscribere	1570 Billingsley
concurrent	f. con + currere	Latin—concurrent-em	1721 Prior "Conversation"
inscribe	f. in + scribere	Latin—inscribere	1570 Billingsley
oblique	f. ob + lique	Latin—obliqu-us	1571 Digges
rectangle	f. recti + angulum	Late Latin—rectiangulum	1571 Digges In sense of Rt. ∠ △.
subtend	f. sub + tendere	Latin—subtendere	1570 Billingsley
supplementary	f. supplementum + ary		1798 Hutton
		French.	
instrument	instrument L. instrument-em	French—instrument	1340 Hampole
similar	similaire or med. L. similaris	French—similaire	1704 J. Harris
vertical	vertical or L. verticalis	A. French—vertical	1571 Digges vertical angle 1704 J. Harris (st. line or plane surface)
Vertical is also given under Latin—classical.			
		Constructed French.	
centroid	f. centre + oid		1876 A. B. W. Kennedy

A QUANTITATIVE ANALYSIS OF AIMS IN TEACHING HIGH SCHOOL CHEMISTRY.[1]

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The data set forth in this paper are based on materials arising from a questionnaire sent, in the spring of 1923, to 550 high schools situated in all the states of the Union. The 187 high schools that made reply are located in thirty-seven states and represent an enrollment of 204,725 students, of whom 18,905 or 9.2 per cent were taking chemistry. Of the 291 teachers represented 80.0 per cent were males, 25.6 per cent have graduate degrees, 7.0 per cent have less than standard bachelors' degrees, and 1.0 per cent have no degree at all. The other data here included are grouped under the headings.

1. Textbooks. Which is a page by page analysis of the five texts most widely used.

2. Teachers' Stress. A compilation of teachers' opinions of importance of things stressed.

3. Final Examination Questions. This is an analysis of 3,600 final examination questions, contributed by eighty-three high schools in thirty-seven states.

Under each of these main headings are the same four subheadings, viz., 1. Descriptive matter, which includes phenomenology and properties of matter. 2. Useful applications. This includes both industrial applications and applications to daily life. 3. Equations and problems. 4. Theory.

Admittedly a quantitative analysis of a textbook, a teacher's ideas, or even a set of final examination questions is difficult and final results are of questionable accuracy, because so much depends on the viewpoint of the individual. In a text, a brief statement of a purely theoretical generalization may be followed by several pages of amplification which in itself is purely descriptive but in its purport theoretical. All that is claimed for the following data is that they approximately indicate general tendencies.

From Table I, it may be seen that most widely used texts are about one-half descriptive matter, one-fourth useful applications and one-fifth theory problems and equation writing; also the portion given to theory becomes slightly greater the more recent the text.

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[1]Read before the Section of Chemical Education at the Milwaukee meeting, 1923, of th American Chemical Society.

1. Textbooks. (Table I.)

TABLE I. ANALYSIS OF EXTENT OF USE AND CONTENT OF TEXTS REPORTED BY 184 HIGH SCHOOLS, REPRESENTING 20,300 STUDENTS.

(All figures represent percentages.)

Author	Stdnts. Using	Descript.	Useful Apclns.	Eqns. & Probs.	Theory
1. Brownlee	43.3%	51.1%	27.9%	6.5%	14.5%
2. McPherson and Henderson	24.8	57.5	24.6	2.8	15.1
3. Black and Conant	10.2	49.2	27.3	7.1	16.1
4. A. Smith	6.9	59.0	25.8	5.4	9.8
5. Newell	2.2	67.2	20.4	2.4	10.0
All others mentioned	12.6				
Total and Averages	100.0%	56.8%	25.2%	4.9%	13.1%

2. Teachers' Stress.

In the questionnaire teachers were asked to indicate in 1, 2, 3, 4 order their opinion of the importance of the following topics:

Descriptive Matter.
Equations and problems.
Useful applications.
Theory.

As a basis of numerical comparison each time one of these items received a first stress it was arbitrarily given a weighted value of 4; a second stress, 3; a third, 2; and a fourth, 1. It is probable that these weightings do not accurately indicate the difference in stress existing in teachers' minds, but the primacy of things purely descriptive in the minds of high school chemistry teachers is unmistakable.

TABLE II. ORDER OF STRESS IN INSTRUCTION AS INDICATED BY 172 HIGH SCHOOL TEACHERS.

	Number of times stressed			
	Descriptive	Useful Apclns.	Eqns. and Probs.	Theory
1st stress	84	45	16	27
2d stress	51	47	46	28
3d stress	25	41	63	43
4th stress	12	39	47	74
Totals wtd. stresses	551	442	375	352
Same on % basis	32.03%	25.69%	21.82%	20.27%

3. Final Examination Questions.

Whatever the content of texts and whatever teachers may stress in instruction, final examination questions play a prominent role in evaluating student attainment. Further, by the

route of student tradition and by accumulated files of examination questions handed down year by year from one student generation to the next, in many instances final examination questions set the goal of student effort. Finally, it seems to the authors that the content of final examination questions reveal more certainly than information from any other source, the actually existing basic aims of each teacher's effort.

For this analysis of final examination questions the college entrance board of the New England and Middle Atlantic states contributed forty-one questions, while eighty-three schools in thirty-seven states contributed 3,609 questions. All schools in New York state, except one, sent regents' questions. Under present circumstances it is not practical to record more than the averages of the percentage content of these questions. Where the figures from which an average is drawn vary widely, the average obtained will have limited significance. The deviations may be as significant as the averages. Such is the present case.

A glance at this table shows fair agreement in giving many descriptive and few theory questions, and poor agreement in other items; 76. per cent of the schools come within $\pm 10.$ per cent of the average of 42.4 per cent for all schools. Still better agreement is shown in the questions given to theory; 93.5 per cent of all schools give less than 20.0 per cent of questions to theory, the average for all schools being 8.5 per cent. In the two middle columns, agreement is poor. Under Useful Applications only 41.5 per cent and under Equations and Problems, 45.6 per cent of the schools come within $\pm 10.$ per cent of the respective averages of 24.4 per cent and 26.9 per cent. In the first three columns the range of content of questions is undesirably wide, nor should the 14.3 per cent of all schools which give not a single question to theory be overlooked. This table holds many possibilities for statistical treatment. We have mentioned only the most obvious items. The averages of the content of final examination questions are shown in Table IV.

General Conclusions and Observations

1. Teaching nigh school chemistry is a man's job. Certainly no such ratio as eight men to two women prevails among nigh school teachers as a group.

2. Perhaps the most important item, indicated by this investigation, is the very small attention given to pure theory all along the line. The showing of 8.5 per cent for high school ex-

amination questions and 6.7 per cent by the New York State Regents certainly does not bespeak a very vigorous attack on the fundamentals. This showing along with the preponderant attention in Teachers' Stress given to descriptive matter and useful applications in a proportion strikingly like that in textbooks would indicate that the backbone of much high school chemistry is a parrot-like repetition of textbook matter.

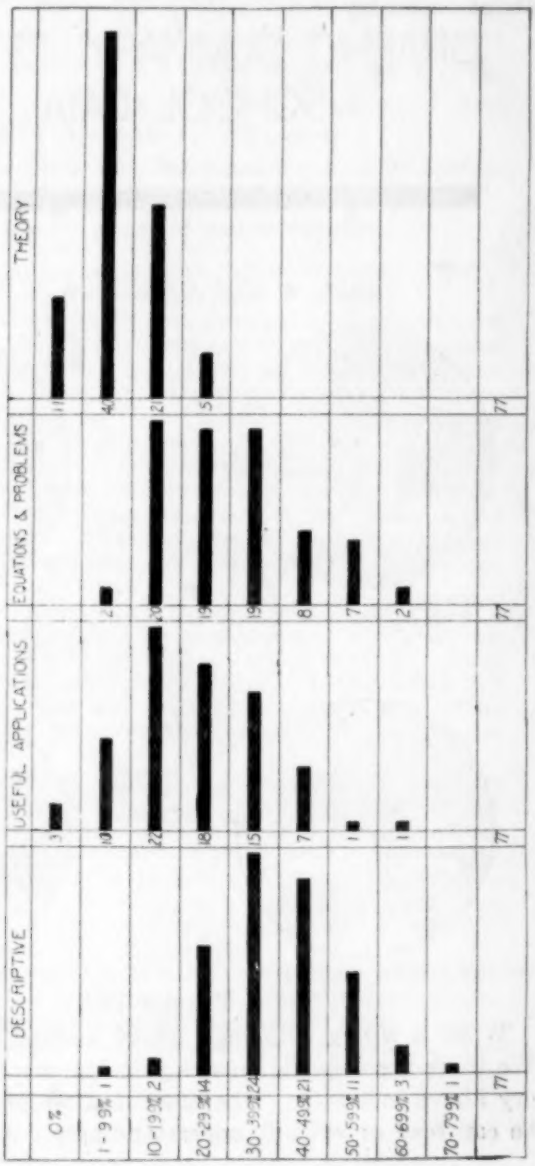

TABLE III.

3. The 24.7 per cent of final examination questions given to equations and problems, indicates a commendable effort at thoroughness in this very important subject. However, those who, in college instruction, must build on high school foundations know that for the most part, high school chemistry students are void of any real understanding of equation writing and chemical arithmetic. The moral—Let us teach more chemistry and less about chemistry.

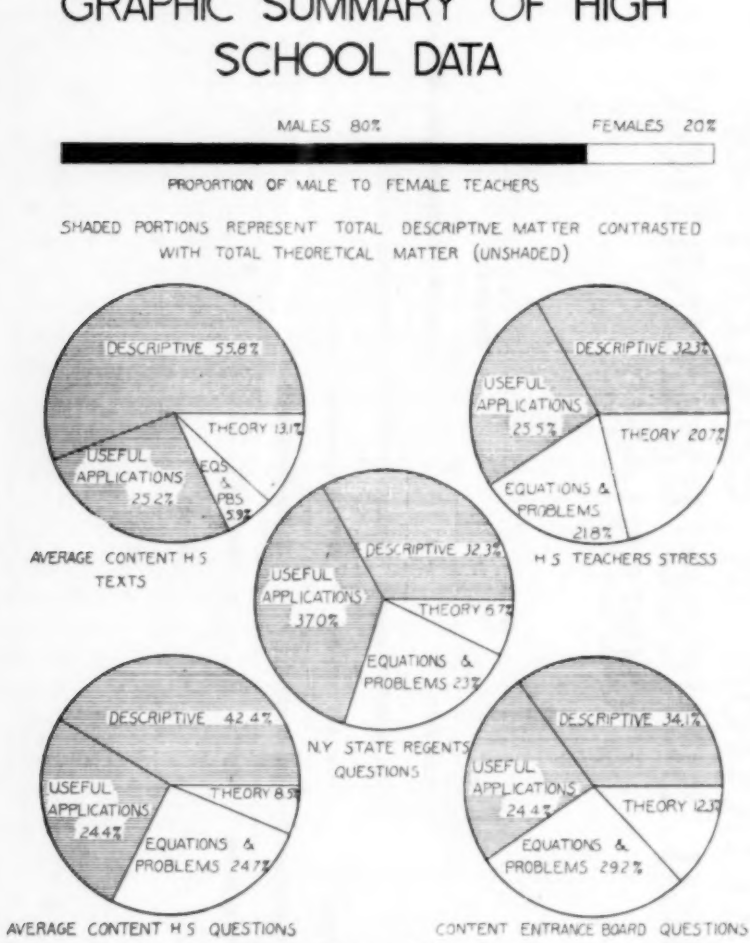

TABLE IV.

What is wrong with high school instruction in these topics? We think possibly the answer is in the short shift given to theory above indicated. One must understand a language before he can read or write it understandingly. And a student must

have some clear ideas of the kinetic theory, mass action and the like before any amount of drill in equation writing will amount to much.

4. The deviations in content of high school final examination questions shown in Table III indicate a wide divergence in aim in teaching chemistry in high schools.

5. It was thought appreciable differences in general aims might exist between large and small high schools, also between high schools in the industrial region of the country north of the Ohio and east of the Mississippi rivers. Segregation of data along these lines revealed no significant differences.

6. We believe high school chemistry is not primarily a memory subject and cannot successfully be taught as such.

MOTHER EARTH HAS HARD, HEAVY HEART.

The earth is built somewhat on the same principle as an old-fashioned metal-cored golf ball, around which are wrapped several layers of lighter material ending in a thin surface crust. The metal core is pure iron or an alloy of that metal with nickel, says a report of Drs. E. D. Williamson and L. H. Adams, scientists of the Carnegie Institution of Washington, to the Washington Academy of Sciences.

They say that it is possible that the inmost core of the earth may be gold, or platinum, or other metals heavier than iron, but that it is practically certain that the center of the earth is an irregular sphere of iron about 4,200 miles in diameter. From the outer edge of this core, which is not sharply defined, to the surface is about 1800 miles, and this distance is divided into three layers.

Next to the central iron core, Drs. Williamson and Adams relate, is a sort of mixed layer of iron and of rock, which extends with a gradually diminishing proportion of iron to within about 900 miles of the surface. Above this is a layer of rock, resembling that found at the surface but containing more magnesia and less silicates. Finally, there is the surface crust, about 35 miles thick, consisting essentially of the granitic rocks.

All this insight into the earth's anatomy is afforded, the scientists say, through a study of the velocity of earthquake waves through the earth, mathematical considerations having to do with the mass of the earth as a whole, and a study of meteorites, whose average composition is believed to closely resemble that of the earth as a whole. For example, it is known that the density of the whole earth is about 5.52 times that of water, while the average density of the surface rocks is only 2.7. There must therefore be something heavier inside.

Pressure has something to do with that, as by squeezing the material of the rocks closer together it would make them denser, but the authors of the report state this would not be enough to cause such a great increase of density as is needed to explain the average density of the earth. The pressure at the center of the earth is calculated to be about 25,000 tons to the square inch.—[*Science Service.*

THE PREPARATION OF TEACHERS FOR HIGH SCHOOL BIOLOGY[1]

By Jesse M. Shaver,

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Many investigators[2] have studied the preparation which high school teachers of biology in various parts of the country have actually had, and have pointed out the inadequacy of this preparation in the case of the average teacher as regards amount and variety of work. These studies through calling attention to certain deficiencies in the training of teachers should result in laws requiring better preparation before the granting of a certificate to teach, better salaries and a greater demand for the better prepared teacher, and smaller salaries and a lessened demand for the poorly prepared teacher. These requirements must of necessity be based on a knowledge of what constitutes adequate preparation for teaching.

In order to determine what is adequate preparation in biology for the teaching of high school biology, the writer examined carefully the courses and requirements in biology as given in the catalogues of ten teachers' colleges in six of the Central States. In this area, according to the Educational Directory, Bureau of Education, Bulletin 50, there are 27 teachers' colleges; so that the ten schools selected constituted 37% of the whole. These sample schools were selected because their catalogues were available for study and not because they were thought to be model or unusual schools.

In this comparison the most conspicuous thing was the great difference in title and sequence of courses in different schools, even in those schools in the same state. From this fact, one might be justified in assuming that every teachers' college has a different idea of what constitutes adequate preparation for the teaching of biology. That a comparison of these ten teachers' colleges with respect to number and title of courses dealing with certain phases of biology and the ratio of these to the total number of hours work given in biology, might furnish a basis for judging of the truth or falsity of this assumption

[1]Read before the Biology Section of the C. A. S. and M. T., at Indianapolis, Ind., November 30, 1923.

[2]Caldwell, O. W., 1909. "The Teaching of the Biological Sciences in Illinois" (?), School Science and Mathematics, IX, pp. 581-597, June. 1916. "Preparation of the Teacher of Biology," School Science and Mathematics, XVI, pp. 385-392, May. Cummins, Harold, 1916, 1917. "Zoological Teaching in Michigan," School Science and Mathematics, XVI, pp. 805-813, Dec.; XVII, pp. 18-24, Jan. Eikenberry, 1913. "First Year Science in Illinois High Schools," School Review, XXI, pp. 542-548. Hopping, Aleita, 1921. "Organization of Biology and Related Sciences in City High Schools," School Science and Mathematics, XXI, pp. 463-472, May. Montgomery, C. E., 1916. "Biology in Indiana High Schools," School Science and Mathematics, XVI, pp. 220-232, March.

seemed plausible. Accordingly, four phases of biology were selected, namely health, field work or outdoor study, courses of an economic, applied or civic nature, and whether general biology or elementary botany and zoölogy were taught.

The result of this comparison as to the health phase of biology is given in Table I below:

TABLE I. HEALTH COURSES IN TEN TEACHERS' COLLEGES OF THE CENTRAL STATES.

No. of school	No. of hrs.[1] of health	Ratio of health hrs. to total hrs. biology	Title of Health Courses Given
1	25	1:4.60	(a) Hygiene and Health Supervision, (b) Physiology and Anatomy, (c) Sanitation, (d) Physiology, (e) Personal and School Hygiene.
2	46	1:3.13	(a) School Hygiene, (b) Personal Hygiene, (c) Health Work in the Schools, (d) Mental Hygiene, (e) Elementary Physiology, (f) Human Body, (g) Institute Physiology, (h) Special Hygiene for Women, (i) Sex Education, (j) Teaching Physiology and Hygiene.
3	5	1:20.00	(a) Human Physiology.
4	15	1:8.66	(a) Physiology, (b) Hygiene and Sanitation, (c) Hygiene.
5	5	1:2.90	(a) Nutrition and Health of the Human Body.
6	15	1:2.33	(a) General Hygiene, (b) School Hygiene, (c) Physiology.
7	10	1:5.40	(a) Physiology, (b) Hygiene and Sanitation.
8	15	1:5.00	(a) Hygiene and Sanitation, (b) Physiology, (c) Preventive Medicine.
9	20	1:4.00	(a) Human Physiology, (b) Personal Hygiene, (c) Child Hygiene, (d) Sanitation and Disease Prevention.
10	20	1:3.80	(a) Problems of Health and Disease, (b) General Survey, (c) Physiology of Digestion and Nutrition, (d) Physiology of Exercise and Physiology of Genetics, (e) Course for Primary Teachers.

This table shows that all of these ten schools give health courses, although one offers health training "on demand" only. This indicates that health training is regarded as desirable for teachers, but the ratio of the health hours to the total number

[1]All units of the various schools were reduced to the hour basis, an hour being one recitation per week for a period of twelve weeks.

of hours offered in biology (including botany, zoology, physiology, bacteriology, health, and hygiene) shows a difference of opinion as regards the importance of health in the curriculum. The highest ratio is one hour of health work to 2 1-3 hours of total work in biology and the lowest ratio is one hour of health to 20 hours of biology, with most of the schools giving health work in the proportion of one hour of health to 5 hours of biology. However, in most of these schools, the extent to which students preparing to be teachers of biology would elect health courses would depend largely upon the advice of the major professor. A glance at the titles of the health courses offered by different schools shows still further disagreement, some offering only human physiology but most giving courses of the hygiene and sanitation type. Undoubtedly, many topics of a health nature are given in other biological subjects besides those with a health label but they could not be considered here because it is not likely that these topics would be so developed as to keep in mind the modern point of view in health education. This modern point of view is to stress training in correct health habits rather than giving reasons for the development of correct health habits.[4]

The result of the comparison of the same ten teachers' colleges as to the field or outdoor work offered is given in Table II:

Of the schools examined, only one gave no field work and even here field trips may have been given in connection with other courses under which they were not listed. The highest ratio of field work to total work in biology was one hour of outdoor work to 4.74 hours of biology, while the lowest ratio was one hour of field work to 23 hours of biology. The average ratio was about one hour of field work to ten hours of biology. This indicates a belief that field work should be given in biology, but a lack of agreement as to the proportion of field work to the total work in biology. A grouping of the field courses under botany and zoology reveals two teachers' colleges offering field work in botany but none in zoology, one school offering field work in zoology but none in botany, four schools offering more field work in botany than in zoology, and two schools offering more field work in zoology than in botany. However,

[4]Downing, E. R., 1923. "The Teaching of Hygiene and Sanitation." SCHOOL SCIENCE AND MATHEMATICS, XXIII, pp. 613-623, Oct., and pp. 739-748, November. Weckel, Ada. 1922. "The Importance of Physiology in Secondary Education." University of Illinois Bulletin XX, No. 29, pp. 105-108. March 19, 1923.

in this comparison nature-study courses were not classed as field courses. They are frequently planned for elementary school teachers and not for high school teachers.

TABLE II. COURSES OF A FIELD TYPE IN TEN TEACHERS' COLLEGES OF THE CENTRAL STATES.

No. of school	Hours field work	Ratio of field work to total hrs. biology	Hrs. field work in botany	Hrs. field work in zoology	Title of courses.
1	5	1:23.00	2½	2½	(a) Tree Study, (b) Bird Study. 2½ hours each.
2	18	1:8.00	4	14	(a) Field Zoology, (b) Birds and (c) Insects, (d) Field Botany, (e) Mammals, 2 hrs. The rest are 4 hours each, (f) Insects.
3	15	1:6.66	10	5	(a) Plant Ecology, (b) Forestry, (c) Animal Ecology.
4	10	1:13.00	10	0	(a) The Local Flora, (b) Plant Ecology.
5	10	1:14.50	5	5	(a) Field Botany, (b) Field Zoology.
6	0	0:35.00	0	0	(a) No field work.
7	5	1:10.40	5	0	(a) Plant Taxonomy and Ecology
8	5	1:15.00	0	5	(a) Animal Ecology
9	15	1:5.33	5	10	(a) Taxonomy, (b) Bird Study, (c) Applied Entomology.
10	17½	1:4.37	12½	5	(a) Forestry, (b) Economic Fungi, (c) Ecology—½ of course, (d) Entomology.

The comparison of these same ten schools as regards biological courses of an economic, applied, or civic nature, is given in TABLE III:

Every school except one offers some courses of this kind. The lowest ratio of biological courses of an economic nature to the total of biological courses offered is 1:18 and the highest is 1: 3.8. In this comparison, no agricultural courses were considered except those dealing with fungi or insects, despite the very great economic value of many of these courses. Six schools gave courses dealing with insects, six gave courses dealing with fungi, four gave courses dealing with forestry, and three gave courses dealing with birds.

TABLE III. BIOLOGICAL COURSES OF AN ECONOMIC, APPLIED OR CIVIC NATURE IN TEN TEACHERS' COLLEGES OF THE CENTRAL STATES.

No. of school	Hours of Economic biology	Ratio of Economic courses to biology	Title of Courses.
1	15	1:7.67	(a) Economic Entomology, (b) Bird Study, (c) Tree Study.
2	24	1:6.00	(a) Farm Biology, (b) Fungi, (c) Bacteria, Yeasts, and Molds, (d) Birds and Insects, (e) Insects, (f) Mammals. (g) Civic Biology. All of the above courses are 4 hr. courses except the one on Mammals which is a 2 hr. course. Only about 1-2 of Farm Biology and 1-2 of Bacteria, Yeasts and Molds, are regarded as of an economic type.
3	10	1:10.00	(a) Forestry, (b) Economic Zoology.
4	10	1:13.00	(a) Forest Botany, (b) Economic Botany.
5	10	1:14.50	(a) Economic Entomology, (b) Nesting and Feeding Habits of Birds.
6	0	0:35.00	(a) No courses of an economic nature.
7	3	1:18.00	(a) Insects and Diseases. Offered under Agriculture.
8	5	1:15.00	(b) The Fungi.
9	5	1:16.00	(a) Applied Entomology.
10	20	1:3.80	(a) Entomology, (b) Forestry, (c) Economic Fungi, (d) Plant Production in the United States.

TABLE IV. GENERAL BIOLOGY IN TEN TEACHERS' COLLEGES OF THE CENTRAL STATES.

No. of school	Hours of General Biology	No. of school	Hours of General Biology	No. of school	Hours of General Biology
1	10	5	0[5]	8	5
2	0[6]	6	0	9	5
3	5	7	5	10	5
4	0[7]				

[5]These two schools offer a 5 hour course in plant biology and a 5 hour course in animal biology.

[6]This school offers a 5 hour course in elements of botany and a 5 hour course in elements of zoology.

[7]This school offers general botany but no zoology whatever.

The facts brought out by the comparison of the same ten teachers' colleges with regard to the giving of "General Biology" courses are indicated by Table IV, below.

This table shows that six of the ten schools give either a course in general biology or principles of biology, two others give courses in plant biology and animal biology, which probably cover the same ground as the general biology course, while two schools offer elementary courses in botany or zoology but no general biology.

All of the above facts force us to conclude that there is no general agreement among these teachers' colleges as to the character and amount of biology which should be offered. This leads us to think that there must be similar disagreement as to what constitutes adequate preparation for the teaching of biology in the high school. If so, we must look elsewhere to find a measuring stick or a method for determining just what constitutes adequate preparation for teaching this subject.

Fortunately, a very good measuring stick has been constructed for us by Dr. Caldwell's Committee on the Reorganization of Biology in the Secondary School[8] and largely adopted by your Committee on a One-Year Fundamental Course of Biological Science[9]. This measuring stick is the aims or objectives of high school biology, namely, health, command of fundamental processes, worthy home membership, vocation, citizenship, worthy use of leisure, ethical character. By the use of this measuring stick, it seems that a representative group of teachers of high school biology could construct a one-year fundamental course in biology. This thing, if we may judge by the report of Dr. Hunter's committee at the high school conference in Illinois of a year ago, is being vigorously prosecuted. When such a course is completed and accepted by any considerable body of high school biologists, teachers' college courses in biology can be planned with definiteness, for they must give the prospective teacher of biology a thorough, rich treatment of the topics which he will be expected to teach. Meantime, teachers' colleges can judge of the adequacy of the preparation which they are giving their students for teaching high school

[8]Caldwell, O. W., and Committee, 1920. "Reorganization of Science in Secondary Schools." Bulletin, 1920, No. 26, Bureau of Education.

[9]Hunter, G. W., 1923. "Report of the Committee on a One-Year Fundamental Course of Biological Science." University Illinois Bulletin, XX, pp. 94-103, March 19; SCHOOL SCIENCE AND MATHEMATICS. XXIII, pp. 656-671, Oct.

biology by applying this same measuring stick (objectives in high school biology) to their own courses to determine whether they are best planned to prepare the teacher for developing these objectives in high school biology. If the biological work is not planned to prepare the teacher to teach biology in such a way as to develop these objectives, obviously it should be re-planned.

As to how to modify the biological work in teachers' colleges so as to better prepare teachers for high school biology is indeed a question but one which the author is foolhardy enough to undertake, but not so much with the idea that the writer's thoughts will add much to the subject but rather with the idea of arousing interest in the study of the preparation which teachers of biology are now getting.

To the writer, it seems that teachers can best be prepared for high school biology, as regards courses usually given in the biological department, by five groups of courses, namely: (1) fundamental or basic courses, (2) health courses, (3) field courses, (4) economic courses, (5) professional courses. Under each group, he would organize courses as follows:

(1) FUNDAMENTAL OR BASIC GROUP.

General Biology, 5 hours, or Animal Biology, 5 hours.
Plant Biology, 5 hours.
Vertebrate Zoology, 5 hours.

(2) HEALTH GROUP.

Personal Hygiene, 5 hours.
Sanitation, 5 hours.
Human Physiology, 5 hours.

(3) FIELD OR OUTDOOR GROUP.

Field Botany and Plant Ecology, 5 hours.
Field Zoology and Animal Ecology, 5 hours.
Economic Entomology, 5 hours. About ½ of course should be field work.
Economic Botany, 5 hours. About ¼ of the work should be field work.
Lower Plants, 5 hours. About ¼ of the work should be field work.

(4) ECONOMIC, APPLIED OR CIVIC GROUP.

Economic Zoology, 5 hours. Invertebrates but no insects.
Economic Entomology, 5 hours.
Economic Zoology, 5 hours. Vertebrates.
Lower Plants, 5 hours. About ½ of course should be of an economic nature.
Economic Botany, 5 hours. Seed Plants.

(5) PROFESSIONAL GROUP.

The Teaching of Biology in the High School, 5 hours. Methods and practice. This would be in addition to the professional courses which all teachers are required to take.

The reasons for giving Group I, Fundamental or Basic Courses, and Group II, Health Courses, are too obvious to need

discussion. On the other hand, field courses in biology are not regarded by all as being important in the preparation of teachers (see table II above), so that the author's reasons for giving so much importance to this subject should be given. First is the necessity which many high school teachers of biology have of collecting their own laboratory material. To do this successfully, they must know this material in the field and know when and where to look for it. If in addition they are acquainted with the appearance in the field of other forms, they can frequently make substitutions of material almost equally good for material which is unavailable. Second is the vitality which a well-planned field trip puts into high school biology and the interest which it stimulates in the students. Studying living things in their natural habitat is the better way. Ideally, good teaching means utilizing anything or everything in the community which will vitalize, illustrate or make concrete the work of the classroom. Teachers cannot be expected to take their high school students on field trips unless they have been taught that field trips are necessary in studying biology. Third, field trips acquaint the prospective teacher with the commoner animals and plants and thus put him in position to answer most of the questions which students will ask about things which they have observed. Such a teacher will soon find that students not in his classes will come and ask questions and even his fellow teachers and members of his community will bring unusual specimens and questions to him. Identification of these unusual specimens, most of which are really very common, and answering these questions, most of which are about common things and relatively easy to answer, will soon acquire for a teacher of biology a reputation for being very learned. This makes it easier to secure funds for laboratory extension and to obtain a fair salary.

In the preparation of teachers, the economic group of courses seem important because they furnish teachers the information needed to relate biology more closely to the problem of making a living and to the economic problems of the community. How this can be done may be indicated best by outlining topics suitable for inclusion in these economic courses.

(a) Economic Zoology, 5 hours. Invertebrates but no insects.

Endamoeba coli, a non-pathogenic inhabitant of the human intestine; Endamoeba histolytica, the cause of amebic dysentery; Amoeba meleagridis, the cause of blackhead of turkeys; Foraminifera, and other Protozoa as chalk builders; Protozoa

and the balance in nature; Protozoans in relation to soil fertility; the malarial organisms: Plasmodium vivax, P. malariae, P. falciparum; coccidiosis of rabbits and fowls; Piroplasma bigeminum, the cause of Texas cattle fever; foot and mouth disease and restrictions on the importation of domestic animals; the sponge industry; boring sponges and the oyster industry; corals as jewelry; corals as land formers; liver flukes; other disease-producing flukes; tapeworms of man and of domesticated animals; the starfish as an enemy of the oyster; earthworms in relation to agriculture; leeches; nematodes causing disease of man such as Ascaris lumbricoides, the round worm of man; Trichina spiralis; Trichiuris trichiuris, the whip worm of man; the hookworm; pinworms; nematode parasites of domesticated animals such as intestinal worms, stomach worms, lung worms, kidney worms; nematode parasites of cultivated plants; the lobster and clam industries; barnacles and other animals as ship impedimenta; poisonous spiders; red spiders and mites on plants; the chigger; chicken mites; mange or scabies of domestic animals; mites and itch of the human being; human ticks; cattle ticks; stinging scorpions; centipeds and millipeds; the oyster, scallop, and clam industries; wood-boring mollusks.

(b) Economic Entomology, 5 hours.

Topics: Cockroaches, locusts, grasshoppers, useful Hemiptera, the chinch bug, seventeen-year locust, onion thrips, corn root louse, aphids, root aphids, Florida white flies, San Jose scale, squash borer, peach tree borer, gipsy moth, brown-tailed moth, bagworm, cutworms, army worms, clothes moth, corn ear worm, codling moth, flour and meal moths, useful beetles, two injurious ladybirds, larder beetles, carpet beetles, tree borers, southern corn root worm, cotton boll weevil, grain weevils, Hessian fly, root maggots, fruit flies, the Federal Horticultural Board, saw flies, useful parasitic bees, the preparation and use of spray materials.

(c) Economic Zoology, 5 hours. Vertebrates.

Topics: Food and Game fish, fish culture, river meadows, means of maintaining our fish supply, the work of the United States Fish Commission, state fish commissions, laws and treaties aiming to protect fish; frogs, toads in relation to agriculture, turtles and terrapins, the Gila monster, poisonous reptiles, what to do for snake-bite, snakes as friends of the farmer, bird enemies of agriculture, bird friends of agriculture, neutral birds, the case of the hawks and owls, of the blue jay,

the yellow-bellied sapsucker, the house sparrow, and the starling, bird enemies and friends of fish, buzzards in relation to the spread of disease, the conservation of wild life, small and large game animals, the economic status of the fox, the raccoon, the opossum, and the skunk, mice, volles and shrews of the field, house mice, rats, rat campaigns, domesticated animals, the improvement of domesticated animals by breeding. (d) Lower Plants, 5 hours. About ½ or 2½ hours of this course should be of an economic nature. Topics are only given for this half of the course.

Topics: Club root of cabbage, water molds, white rusts, molds in the home and in the field, yeasts, mildews, fungicides, plant wilts, scab of wheat, bitter rot of apples, chestnut bark disease, fruit tree cankers, black knot, ergot, smuts of the cereals, rusts of the small grains and of the apple, pear blight, edible fungi, poisonous fungi, bacteria in relation to the nitrogen cycle, legumes, bacteria useful in the dairy industry, vinegar manufacture, colds, influenza, tuberculosis, venereal diseases, typhoid, pneumonia, measles, scarlet fever, whooping cough, water and disease, milk and disease, sanitation.

(e) Economic Botany, 5 hours.

Topics: The extent and location of our coniferous forests, the uses of coniferous woods, pulp wood, artificial silk, turpentine and naval stores, the extent and location of our hardwood forests, problems in the utilization of woods, the work of the United States Forestry Service, state forestry bureaus, why protect our forests, waste, forest regeneration, the wind break, the farm woodlot, cereals, forage grasses and legumes, crop plants, fruit trees, cultivated plants, poisonous plants, medicinal plants, crop plants, the extent to which crop plants are utilized in agriculture, climatic and other factors limiting the use of crop plants, methods of raising and handling our important crop plants, the Plant Introduction Bureau, the improvement of plants by breeding.

Group V, Professional Courses, hardly needs any comment since practically everyone is agreed that the general courses in the principles and practices of teaching should be supplemented by a teaching course in the particular subject which the student wishes to teach.

By way of summary, it should be stated:

(1) That biological courses in ten teachers' colleges in six Central States do not agree as to what constitutes adequate

preparation for the teaching of high school biology. This is indicated by the different stress put on various phases of biology by different schools as is shown by the tables given.

(2) That the clear statement of the aims of high school biological teaching by a committee of the N. E. A. and by other committees has provided to a certain extent a measuring stick for aiding in the construction of a high school course in biology. This high school course determines what kind of courses should be given in schools preparing high school teachers.

(3) That in the opinion of the writer the usual teacher training course in biology for preparing high school biological teachers should be modified so as to include five phases of biology, namely:

A. Fundamental or basic courses.
B. Health Courses.
C. Field or Outdoor Courses.
D. Economic, Applied or Civic Courses.
E. Professional Courses.

FADS AND FANCIES IN PHYSICS TEACHING[1]

By N. Henry Black,

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What is a "fad"? According to Webster's Dictionary it is a hobby, whim, craze, custom, amusement followed for a time with exaggerated zeal. We are perfectly familiar with the use of this term as applied to dress and sport and are accustomed to point out the fads of others. But in our own teaching we are likely to dub them by the milder term of hobbies, if we acknowledge them at all. But the fact is that if we are alert and alive and have any individuality about us, we are bound to have some fads. Whatever we think about ourselves, our pupils are very quick to size us up, especially with respect to our idiosyncrasies.

The teacher seems to me to be peculiarly subject to fads, for we are all so anxious to be up-to-the-minute in our methods of work that we seize upon any new idea that promises well. Especially is this true with school executives. To be sure, some are so reactionary that they positively refuse to recognize that education is progressing and so follow no fad except that of being old-fashioned. But the younger generation is all too ready to accept the latest educational dogma as a panacea for our age-long difficulties. Now for teachers the really difficult task is to recognize what are fads and what are truly progressive movements in education. Time alone will decide

[1]This is an abstract of a talk delivered November 30, 1923, at Indianapolis before the Physics Section of the Central Association of Science and Mathematics Teachers.

which of today's fads will be accepted as the educational practice of tomorrow.

Fads of Yesterday. Let us get down to the real business of discussing fads in physics teaching. We shall illustrate by taking some of the fads which have been abandoned, at least in some localities, in their original form.

Thirty years ago, owing to the efforts of Harvard University and the so-called Hall and Bergen course, most physics teachers were laboring very hard to teach physics by the *inductive method.* This did a great deal of good because it was a reversal of the textbook practice then current and was in line with scientific work in the college laboratory. But the mistake came in the assumption that all of our physics instruction with all high-school boys and girls could be given by the experimental and inductive method.

Another fad that arose at about the same time was the enthusiasm for *quantitative measurement.* This was handed down to us by universities and technical schools, and many of the younger teachers who were fresh from their laboratory courses in physical measurement tried with great zeal to arouse in their high-school pupils this same enthusiasm for quantitative measurement. But a few years of experience showed that the average boy or girl in his teens is not tremendously enthusiastic about the discussion of percentage error. It is the bigger things in the physical world which are most interesting—the hows and the whys of everyday machinery. In short, this was a good idea, but carried to an extreme.

A third fad which grew up when the laboratory idea of teaching physics was introduced was the assumption that most of our apparatus could be *home-made.* Many of us can remember afternoons, evenings, and Saturdays spent with or without the help of some of our handy pupils in building apparatus. Often the results were not very satisfactory, and most of us will confess that we should now be better off if we had spent those afternoons in playing golf or tennis. In other words, apparatus can now be built better in the factory than in the laboratory workshop with its inadequate tools and amateur mechanics.

In those days also when apparatus was so new and expensive it was one of the big ideas that one piece of apparatus should be made to serve for many different experiments—the so-called *seven-in-one apparatus.* Of course we all know that certain apparatus should be used again and again, but the mistake made was in trying to devise experiments

solely for the purpose of using some special pieces of apparatus.

In certain localities where the laboratories and physical equipment were adequate, the popular demand was that physics be made easy and interesting, and this led many teachers to devise *bizarre lecture-table experiments* with liquid air and with X-rays, and spectacular experiments with static electricity. These experiments not only took a great deal of time on the part of the teacher, but they left with the pupil a very small residue of either permanent interest or training in real physics.

Finally, to mention but one more of these fads of yesterday, I would call attention to the devotion, we might call it, to *technical nomenclature*. Some of us teachers seemed to feel sure that if we could only get our pupils to use the words of physics, such as *mass*, *inertia*, *momentum*, that clear ideas would be carried with the terms. Unfortunately, experience shows that the idea must come first and then the terminology follows as a matter of course.

In all of these outgrown fads we see a germ of valuable truth, but carried to extreme they often proved a serious handicap to the pupils and surely did much to discredit the value of physics as a high-school subject.

Fads of Today. Now what are some of the fads of today? This is really a very dangerous subject for discussion, since I am bound to step on some one's pet hobby. You will please accept what follows merely as my own personal opinion and give it value only in so far as it agrees with your own point of view.

As I see it, perhaps the biggest fad on the landscape today is our fondness for *new educational terms*. For example, we see and hear much just now about the *problem* or *project* method of teaching this, that, or the other subject. Now, in many cases when you question into the method designated by these terms, you find that there is nothing really new except the use of the term. On the other hand, we all recognize that there is here a valuable idea, namely, that of arousing the initiative and interest of the pupil, and making the work really vital in his everyday life. But most good teachers of physics, and other subjects, have been for years making constant use in their work of the so-called problem or project method. Much more I would like to say on this subject, but time forbids.

Another fad of today is the *over-organization of our work*. Here we have but responded to the spirit of the times. Big business has been successful partly because of the remarkable organizations which have been built up. The rapid increase

in the number of high-school students in this country has made big high schools inevitable. Our classes are too large. The work which any particular teacher has to do is too heavy. There are not enough teachers. The result has been that the overworked teacher has had to look about for means and devices for organizing his routine work so as to reduce the daily grind. This has led, for instance, to the *fixed form of notebook*. These in some cases have gone to the extreme of becoming merely blank forms in which certain words and numbers are inserted, together with the pupil's name and date at the top. We all agree that this is not the ideal way to keep notes in physics. It is not the way the engineer or the research worker makes his notebook. What we actually want is to get the student into the habit of putting down in an orderly fashion what he really sees, what he really measures, all his computations, and what results he thinks he has got from the experiment. Therefore, any stereotyped form, such as *purpose, apparatus, description, data, computations, results and conclusions, errors*, must be regarded as but a temporary makeshift for the overworked teacher who has to correct a large number of notebooks.

Another example of over-organization of our work is the fixed program that most of us have to use in our daily work. We may have a lecture room and nearby a laboratory. On certain days we go to the laboratory and some other class uses the lecture room, or *vice versa*. The result is that a natural interrelation between laboratory and classroom discussion is handicapped by the fact that we have to abide by a fixed schedule in the use of our rooms. In some of the newer buildings, the laboratories are constructed with a small section set aside with raised seats for demonstrations. In this way the teacher has more liberty to adapt his work to the needs of the subject matter.

In our large classes we have also come to use stereotyped or standardized forms of apparatus. This has led both teacher and pupil to associate principles with one particular form of illustrative apparatus, rather than to try to devise some apparatus to solve the particular question at hand. For example, let us not associate Boyle's law exclusively with the J-tube form of apparatus.

Another fad of today is the *over-comprehensiveness of our physics courses*. This, I must say frankly, is largely the fault of the textbooks. No author dares to leave out anything. The subject is growing by leaps and bounds, and the result is that almost

any textbook made in the last ten years contains fifty per cent more material than any sane teacher would attempt to teach his pupils in one year. And yet many an inexperienced teacher is trying to cover the book in a school year, the result being that everything about physics is scrambled, hazy, and vague in the pupil's mind.

So many of us teachers have been trained in colleges where the research work in physics, and many of the courses, were theoretical in their point of view, that the main interest of young teachers has been in the *theories of the subject*. Physical theories are useful, in my mind, in so far as they explain the essential physical facts and laws and should be introduced only when they can help us to understand these facts and laws. Therefore, I would suggest that we lay much less stress on the molecular theory, on the kinetic theory of gases, and on the electron theory of electricity, and put more stress on the fundamental principles involved in the study of gases and electricity.

Finally, let me speak of one more of the current fads, for which I may be more or less responsible. In our effort to make physics a more *"practical"* subject, I fear that some of us have gone to the extreme of teaching machines, devices, and apparatus, rather than the principles which they illustrate. Commercial machinery is changing so fast that even if we could teach the whys and wherefores of much of the present-day machinery, in ten years it would be obsolete and so lose its value as illustrative material. As an example of that, about fifteen years ago I had some lantern slides made of the automobile engine, etc., to illustrate certain principles of physics. Occasionally I show some of these slides, and the boys always laugh uproariously and ask if automobiles were ever made like those illustrated in the pictures.

In this connection I would also like to say that I find very little use in casually referring to modern appliances unless I can spend time enough to show clearly how they illustrate fundamental principles.

Some of my own fads. Here is where, I suppose, I ought to stop or perhaps ought to have begun, for we all like to talk about our own hobbies, but I recognize that these may not interest you even though they seem to me important. However, I cannot forbear stretching your patience a little while I mention a few of them.

In the last half-dozen years I have become greatly interested, as you doubtless have also, in the so-called *intelligence test*.

This seems to me to be a fad that has come to stay, and so perhaps we should say it is one of the forward movements in our educational work. Why? Because it gives us some idea, not always trustworthy, but at any rate it gives us more than we have been able to get in our regular school routine, of the inherent capacity and alertness of the pupil that comes to us. Surely that is half the job of teaching physics—to understand the boy and the girl, their interests, needs, and capacities. Therefore I would urge you to get in touch with the work of some of the educational psychologists, such as Terman, Thorndike, and Dearborn, and find out what help they can give you in estimating the native ability of the boy or girl.

Second, along the same line, I believe that in the next half-dozen years we are going to see some *standardized tests* devised which will enable us in a comparatively short time to measure roughly the effectiveness of our methods of teaching. In other words, we shall be able to measure roughly the efficiency of our work. There are many (such as Glenn of the Lincoln School) who are working at this problem, and I feel sure that it is the next step toward the improvement of our work as teachers.

Another hobby of mine is that the teacher himself must keep on *studying his subject*. There are many ways—the summer school, an occasional year off, reading the current magazines and the newer books for school and college use. Right here I cannot forbear calling your attention to a recent book called GENERAL PHYSICS FOR COLLEGES by *Webster*, *Farwell*, and *Drew* (Century Co.). This is not intended for high-school use, but is only for college use, as the title indicates. I would especially urge that you read the last 125 pages dealing with modern physics, which is the part of physics that deals with our modern theories as to the nature of matter and electricity. To my mind this book contains the best statement in brief form that I have been able to get hold of.

Another hobby—notice I say "hobby," not "fad," because it is my own—is that the teacher must *keep experimenting* with his own hands. If you don't, you soon get out of the spirit of experimental science. There is no better way to arouse the interest of the pupils than to let them see that the teacher is doing experiments too. Few of us have the equipment for doing research work in the sense in which this term is used in our universities, but surely there are a vast number of teaching and apparatus problems waiting to be solved by the patient work

of teachers. For example, several years ago I made a comparative study of d'Arsonval galvanometers, comparing all the galvanometers which I could borrow or otherwise secure. Lately, I have been working with different types of vacuum pumps, and it is surely interesting to see the development in the last ten years in commercial vacuum pumps. Probably all of us are following radio, and that in itself would keep us busy if we tried to keep up with our radio fans.

Finally, I have a very firm conviction that every teacher must *go outside his laboratory*. See other teachers at work; meet other teachers at educational conventions; and perhaps most of all come in contact through the factory and repair shop with machinery as it is used commercially today. In these days it is not difficult for a teacher to get opportunity to work for two or three months in the summer in a big industrial organization, and anyone who has tried this comes away with much food for thought and a background for his own teaching and experimental work which is a treasure.

If there were time I would like to discuss with you in some detail how we may more effectively teach the principle of parallelogram of forces as applied to real bridge trusses and derricks by *isolating* a single point or member. (See Chapter II in Webster, Farwell & Drew's General Physics.) Or perhaps we might consider how we may more effectively teach Ohm's law as applied to *partial circuits*. (See Chapter III in Timbie's Elements of Electricity.) Someday we shall understand how almost every important principle of electricity is illustrated in an ordinary *radio receiving set*. (If you doubt this statement, get the Government's Radio Pamphlet No. 40.) These and many other subjects I can only refer to as interesting fads worth studying.

In conclusion, let me say that I am not here to advocate any particular fads of my own so much as to urge that each one of you should have some fads or hobbies about your own work. Get some fads! Be willing to compare notes with your neighbor, to try out his fads to see how they work, and to let the rest of us know the results. Only by this co-operation can we hope to advance in our profession Don't accept every new fad but look into it, study it from several points of view. Often it is not really new but is an old idea in a new gown. However, it may be a real step in advance, at any rate almost any fad has some good idea back of it. Let us apply our scientific spirit to our teaching methods.

DEMONSTRATION STUDY OF COLORS IN AUTUMN FOLIAGE

By Helen A. Choate,

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One of the most interesting and pertinent topics for discussion in botany classes in the fall, especially in the eastern part of the country, is that of the coloration of autumn foliage. Such a topic, involving as it must, some account of chlorophyll as the basal pigment of leaves, makes not only a good introduction to a further study of its function in connection with photosynthesis, but at the same time gives an excellent opportunity for the interpretation of a phenomenon so common and striking as to attract the attention and interest of all.

Much is added to the interest of such a discussion if in connection therewith the more important autumn colors are shown as extracted from the leaves. Successful methods for the extraction of these colors or pigments have been worked out in the Laboratory of Plant Physiology at Smith College, simplified from the somewhat more elaborate methods described in various texts. It has been our custom to prepare each fall four demonstration bottles containing respectively (1) the green pigments (chlorophyll); (2) the yellow pigments (xanthophyll and carotin); (3) a separation showing by differential solubility that the so-called chlorophyll of bottle (1) contains in reality both chlorophyll and the yellow pigments of (2); (4) the red pigments (anthocyanin, formerly known as erythrophyll). These pigments thus extracted are, of course, not the pure substances used in investigation, but are sufficiently near for demonstration purposes. The bottles used are ungraduated measuring bottles with ground glass stoppers, the best results being obtainable if the diameter is not too great. Those approximately 30 cm. high and holding about 300 cc. are a very convenient size. Such a series as this, when well prepared in good clear solutions, makes a surprisingly beautiful display, the colors showing with remarkable brilliance especially if placed in front of a window or other good source of light.

Methods of Extraction:

Green pigments: Take any good green leaves (grass is excellent and can be obtained easily); cut into small pieces and cover with ninety-five per cent alcohol; allow it to stand two or three days in the dark; filter. Care must be taken not to have the extract too dense, otherwise it will not show clearly its character-

istic green color. After being prepared it must be kept in the dark until used, as it fades quickly.

Yellow pigments: Treat yellow leaves with alcohol as above. For material elm leaves are good. Many yellow leaves such as horse chestnut and birch contain other substances (flavones, etc.) which after a short time turn the solution brown.

Separation of green and yellow pigments: The quantities here specified are those needed to fill one of the 300 cc. demonstration bottles previously mentioned and the method is essentially that given in Thatcher's Chemistry of Plant Life. Make an alcohol or acetone extraction of chlorophyll as described above; filter; take 100 cc. of filtrate, pour into separatory funnel and add 125 cc. of ether and 200 cc. of water; shake up once and then allow the ether layer to separate. All the pigments will be in this layer. Drain off the water-alcohol (or acetone) layer; put 100 cc. of the etherial solution in the demonstration bottle, add 50 cc. of a concentrated solution of KOH in methyl alcohol, shake well and allow to stand until the mixture becomes permanently green; then add 145 cc. of water and 5 cc. of ether. The green pigments will then be in the lower dilute alcoholic-potash layer and the yellow pigments in the upper ether layer. As the ether evaporates slowly in spite of careful sealing, more should be added as needed if the solution is to be kept any length of time.

Red pigments: After considerable experimentation *Vaccinium* leaves have been found to be most satisfactory, though other red leaves such as *Ampelopsis quinquefolia* (woodbine) or *Ampelopsis Veitchii* (Japanese or Boston ivy) may be used. Cut the material into small pieces and cover with water, having a large amount of material in proportion to the water; let it stand four or five days in the dark, stirring occasionally; filter, preferably with a filter pump, as otherwise the filtration is extremely slow.

An additional feature of interest is secured by leaving the bottles in the light during the year to contrast the stability of the various colors. It will be noted that while the chlorophyll in alcoholic solution is very unstable, and the xanthophyll and carotin in alcohol are also unstable, both the former in its saponified form in alcoholic-potash and the latter in solution in ether are very stable.

PROBLEM DEPARTMENT.

CONDUCTED BY J. A. NYBERG.
Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to J. A. Nyberg, Hyde Park High School, Chicago.

LATE SOLUTIONS.

805. *Oscar Fox, Orville Pollard, Needles, California.*

SOLUTION OF PROBLEMS.

806. *Proposed by Norman Anning, Ann Arbor, Michigan.*

A careless student wrote: $\sin(12°)^2 = \sin^2 144°$, which is not true. If he had written: $(\sin 80°)^2 = \sin^2 6400°$, it would have been true. Find positive integral values of x less than 90 for which the square of the sine of x degrees is equal to the square of sine of x^2 degrees.

Solved by Philomathe, Montreal, Canada.

If $\sin^2 x^2 = \sin^2 x$ then $x^2 = 180k \pm x$ or $x^2 \pm x = 180k$ where k is an integer. To find easily the integral solutions of this equation we note that the left member is the product of two consecutive integers. Hence the prime factors of 180 show that k can equal 7, 11, and 36. If $k=7$, then $x=36$ or 35. If $k=11$, then $x=45$ or 44. If $k=36$, then $x=81$ or 80.

Similarly solved by *Michael Goldberg, Philadelphia, Pa.*, and *J. F. Howard, San Antonio Texas.* *Goldberg* also proved that no fractional values of x are possible for if a/b were a fractional value reduced to its lowest terms then

$$\frac{a}{b}\left(\frac{a}{b}+1\right) = \frac{a^2+ab}{b} = \frac{a(a+b)}{b^2} = \text{an integer},$$

Which is impossible unless a has the factor b. Similarly $\sqrt{a}$ can not be a solution for then $\sqrt{a}(\sqrt{a}+1)$ or $a+\sqrt{a}$ must be an integer.

We might also mention the obvious solutions $x=0$ and $x=1$.

807. *Proposed by Michael Goldberg, Philadelphia, Pa.*

Prove that $\tan\frac{2\pi}{7}\tan\frac{4\pi}{7}\tan\frac{6\pi}{7} = \sqrt{7}$.

Solved by Norman Anning.

Let $7\theta = \pi$. Then $0, \theta, 2\theta, 3\theta, 4\theta, 5\theta, 6\theta$ are values of x for which $\sin 7x = 0$. The last six are values of x for which $\sin 7x/\sin x = 0$. Expanding $\sin 7x$ in powers of $\sin x$ and $\cos x$ and dividing both members of the equation by $\cos^6 x$(which is not zero) we have the equation

$$\tan^6 x - 21\tan^4 x + 35\tan^2 x - 7 = 0.$$

From the theory of equations we know that tne product of the roots of this equation is -7 or

$$\tan\theta \tan 2\theta \tan 3\theta \tan 4\theta \tan 5\theta \tan 6\theta = -7.$$

But $\tan\theta = -\tan 6\theta$ (a positive number), $\tan 3\theta = -\tan 4\theta$ (a positive number), $\tan 5\theta = -\tan 2\theta$ (a negative number). Hence

$$\tan 2\theta \tan 4\theta \tan 6\theta = \sqrt{7} \quad (\theta = \pi/7).$$

Also solved by *J. F. Howard* and *Philomathe.* Some interesting special cases and also generalizations of this relation are found in Loney's Trigonometry, part II, page 145.

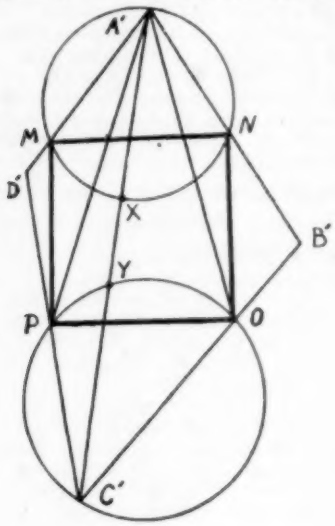
808. *Proposed by J. F. Howard, San Antonio, Texas.*

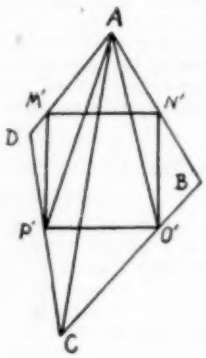
Inscribe a square in a given quadrilateral.

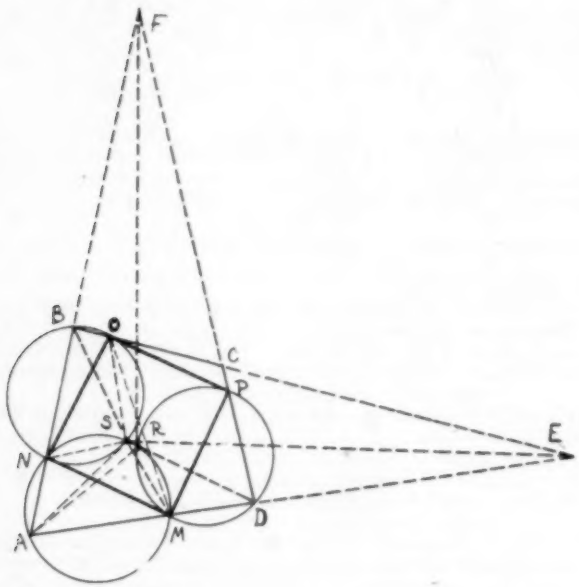
Solved by Philomathe, Montreal, Canada.

ABCD is the given quadrilateral. On the sides MN and OP of any square construct segments of circles containing the angles DAB and DCB. Locate the points X and Y by using the fact that arc MX must

equal twice $\angle DAC$ and arc $PY = 2\angle DCA$. Draw the line XY intersecting the circles at A′ and C′. Join A′ to M and to N and C′ to P and to O forming a quadrilateral. Construct $\angle DAP' = \angle D'A'P$ and $\angle BAO' = \angle B'A'O$ thus determining the points P′ and O′. The square constructed on P′O′ is the desired inscribed square.







Solution by the Proposer.

Analysis. ABCD is the given quadrilateral and MNOP is the desired inscribed square. About $\triangle AMN$, $\triangle BNO$, $\triangle DMP$ circumscribe circles intersecting in S and R respectively. Then

$$\angle BSA = \angle NSO - \angle BSO + \angle NSM - \angle ASP$$
$$= 180 - \angle NBO - \angle BNO + 180 - \angle NAM - \angle ANM$$

$=180-\angle NBO-\angle NAM+180-(\angle BNO+\angle ANM)$
$=\angle E+\angle ONM=\angle E+90.$

Also, $\angle BSA+\angle BSO+\angle OSM+\angle ASM=360.$
$\therefore 90+\angle E+\angle BNO+\angle ANM+\angle OSM=360.$
$90+\angle E+90+\angle OSM=360$ or $\angle E+\angle OSM=180.$

Hence a circle can be circumscribed about OSME, and therefore $\angle BES=\angle OMS.$

$\angle BSE=180-\angle SBO-\angle BES=180-\angle ONS-\angle OMS$
$=180-(90-\angle SNM)-(45-\angle SMN)$
$=180-90+\angle SAM-45+\angle SAN=45+\angle A.$

Likewise, $\angle ARD=90+\angle F$ and $\angle ARF=45+\angle D.$

Construction. On AB construct a segment of a circle containing an angle equal to E+90; on BE construct a segment containing an angle equal to A+45. The intersection of these segments gives the point S.

On AD construct a segment of a circle containing an angle equal to F+90, and on AF a segment containing an angle B+45. Their intersection is the point R.

Construct a circle through R, S, and A. This circle will intersect AB in N and AD in M, two vertices of the square.

809. *Proposed by James Singer, Ithaca, New York.*

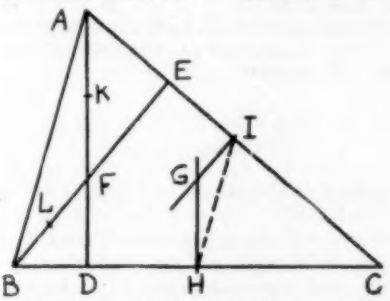
Given $\triangle ABC$ and a point P within it. From the vertices A, B and C draw lines AM, BN, CL through P and terminated by the sides of the triangle. AB produced meets NM produced in a point X; similarly BC and LN intersect at Z and AC and LM intersect in Y.

Prove that the points X, Y, and Z are collinear.

Solutions of this problem using the methods and theorems of Projective Geometry have been received from *Michael Goldberg, R. T. McGregor, Elk Grove, Cal.*, and *Philomathe*. Briefly stated, the Theorem of Desargues is: If two triangles (as $\triangle ABC$ and $\triangle LMN$) have their vertices in pairs on three concurrent lines (as A and M, B and N, C and L), then the corresponding sides (as AB and MN, AC and LM, BC and LN) intersect in points (as X, Y, Z) which are collinear. To solve the problem without using projective geometry we may use what is really a special case of the above theorem; namely, the Theorem of Menelaus: A line intersecting the sides of a triangle determines upon the sides six segments, such that the product of three non-consecutive segments equals the product of the other three segments. The following solution by *J. F. Howard* is based on this theorem and its converse.

Since AM, BN, CL intersect in P, then

(1) $BM\times AL\times CN=BL\times AN\times CM.$ (Theorem of Ceva).



The Theorem of Menelaus applied to the transversals MLZ, NMX, and NLY gives:

(2) $BM\times CZ\times AL=BL\times CM\times AZ$
(3) $CN\times AX\times BM=CM\times AN\times BX$
(4) $AL\times BY\times CN=CY\times AN\times BL.$

The product of (2), (3), (4) is

$AX\times BY\times CZ=AZ\times BX\times CY$ when use is made of equation (1). Hence XYZ is a straight line.

The editor hopes that the occasional reference to a problem of this kind will stimulate an interest in Projective Geometry.

810. *For High School Pupils.*

The altitudes BE and AD of $\triangle ABC$ intersect at F. The perpendicular bisectors of AC and BC intersect at G. H is the mid point of BC and I the mid point of AC.

Prove that BF = 2 times GI.

At the first glance at the solutions of these problems the editor felt he would be entirely unable to select the best one. There were, however, a few touches here and there where some pupil showed a more careful analysis than usual. The simplest proof uses the fact that $\triangle GHI$ and $\triangle ABF$ are similar because their corresponding sides are parallel. (HI]] AB because HI joins the midpoints of two sides of the $\triangle ABC$). Hence any proof which used the line KL, joining the midpoints of AF and BF, was not the simplest proof. After proving the triangles similar, we note that the ratio of similitude is 1 to 2 since $IH = \frac{1}{2}AB$. Frequently after getting this far a proof becomes rather vague as to why $GI = \frac{1}{2}BF$. The best way to get this equation is to use the proportions $IH/AB = GI/BF$ and $IH/AB = \frac{1}{2}$ which lead to $GI/BF = \frac{1}{2}$ or $2GI = BF$. Of course if the pupil has not reached the chapter on similar triangles then the use of the line KL is necessary.

The three best proofs were by: *Orville Pollard, Needles, Cal., John H. Altergott, Northeast H. S., Kansas City, Mo.*, and *Roger Becker, Central H. S., Evansville, Ind.* Also solved by the following pupils of the *Northeast H. S., Kansas City, Mo.: G. Dunn, Jane Gleason, Faye Henderson, Helen Lord, Boldy Lux, Frances Osborne, Frank Smith.*

PROBLEMS FOR SOLUTION.

821. *Proposed by Burrell Morgan, Krollitz, W. Va.*

The hypotenuse of a right triangle is h and the side of the largest inscribed square is s. Find the sides of the triangle.

822. *Proposed by J. J. Sheekey, St. Joseph's Normal Institute, Ammendale, Md.*

If a^2, b^2, c^2 are in Arithmetic Progression show that $(b+c)$, $(c+a)$, $(a+b)$ are in Harmonic Progression.

823. *Proposed by Norman Anning, Ann Arbor, Mich.*

To cut an acute triangle into four triangles in such a way that their areas illustrate the identity.

$$\cos^2 A + \cos^2 B + \cos^2 C + 2 \cos A \cos B \cos C = 1.$$

824. *Proposed by Jonas T. May, Mattoon, Ill.*

Construct a trapezoid given the four sides.

825. *For High School Pupils.*

If from the extremities of a diameter perpendiculars be drawn upon any chord (produced, if necessary), the feet of the perpendiculars are equidistant from the center.

NOTICE

The annual meeting of the National Council Supervisors of NATURE STUDY AND GARDENING will be held in the Rose Room of the Great Northern hotel, Chicago, Saturday February 23, 1924.

Morning session will begin at ten o'clock. A very interesting and elaborate program has been arranged. Many teachers of prominence appear on the program. All people interested in this particular phase of work are invited to be present.

LESTER S. IVINS,
Kent College, Ohio.

REPORT OF THE ANNUAL CONVENTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

INDIANAPOLIS, NOVEMBER 30 AND DECEMBER 1, 1923.

The general session opened at 10 a. m., Friday, November 30, in Cabel Mills hall, Shortridge high school, President Frank B. Wade presiding. The program follows:

Music—Shortridge high school orchestra, directed by Mr. C. E. Palmer.

Address of welcome—Mr. George Buck, principal of Shortridge high school.

Response in behalf of the association—Mr. Frank B. Wade, President.

Address—"Pre-medical Mathematics and Science"—Charles P. Emerson, M. D., Dean of the Indiana University School of Medicine.

Address—"Aims of Education"—A. A. Potter, Dean of the School of Engineering, Purdue University.

The annual dinner was held at the Spink-Arms hotel at 6 p. m. Mr. Simon Roache of Indianapolis was toastmaster. Approximately two hundred teachers from Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kentucky, Tennessee, Ohio, Michigan, Massachusetts and New York responded to roll call by announcing their names, position, school and other items of interest.

Miss Hope Bedford of the History Department of the Shortridge high school sang several songs.

Prof. H. E. Slaught, University of Chicago, responded to the toast "Mathematics and the Other Sciences," and demonstrated his ability to make a serious address both interesting and entertaining. For over an hour he kept the audience roaring with laughter while he proclaimed facts and principles of Euclid, Newton and Descartes.

Short pep talks were given by Mr. N. Henry Black, Roxbury Latin School, Boston; Mr. W. W. Hart, University High School, Madison; Mr. Rawleigh Schorling, Ann Arbor and Herbert Smith, Chicago.

The annual business meeting was held in Cabel Mills hall Saturday at 9 a. m. The business transacted included the following reports:

Report of the Treasurer, I. N. Van Hise, Chicago Normal College, Chicago, Ill.

Report of the Committee on Resolutions, Charles H. Smith, Hyde Park high school, Chicago, Ill.

Report of the Committee on Necrology, C. M. Turton, Bowen high school, Chicago, Ill.

Report of the Committee on Membership, C. M. Sharp, Emmerich Manual Training high school, Indianapolis.

The Association gave Mr. Sharp a special vote of thanks for his valued work and strongly recommended to the new president that he continue Mr. Sharp in this work.

Report of the Auditing Committee, Raymond W. Osborne, Francis W. Parker School, Chicago, Ill.

Mr. Hart, Chairman of the Steering Committee, could not be present but recommended to the president that the work of this committee be turned over to the Executive Committee.

Report of the Nominating Committee, Warren C. Hawthorne, Crane Junior College, Chicago, Ill.

This committee presented the following:

President, Clarence L. Holtzman, Waller high school, Chicago.

Vice-President, T. D. Kelsey, Cleveland high school, St. Louis.

Treasurer, W. G. Gingery, Shortridge high school, Indianapolis.

Assistant Treasurer, Ira C. Davis, University high school, Madison.
Corresponding Secretary, Katherine Ulrich, Oak Park high school, Oak Park, Ill.

The secretary was directed to cast the unanimous ballot for these nominees. Glen W. Warner, Englewood high school, Chicago, was elected secretary in 1922 for two years.

Crane Technical High School and Junior College, Chicago, was selected as the place for the 1924 meeting. The main topic adopted for discussion is "The Junior High School."

GLEN W. WARNER, Secretary.

THE RESOLUTIONS.

Be it resolved that we extend to the Indianapolis Board of Education our great appreciation of the courtesies which they have extended to us for the use of the Shortridge high school without expense. Rarely has such hospitality been given to an organization of this character. We also extend to Mrs. Craig of the Shortridge high school for the magnificent luncheons which have been prepared for us, our sincere appreciation. We wish to extend to Miss Martha Hunt of the Shortridge high school, Chairman of the Reception Committee, our appreciation for the delightful entertainment she so efficiently managed the last evening. It was unique in character, being enjoyed by every one present.

Resolved further that we appreciate the untiring efforts of Mr. C. M. Sharp of the Shortridge high school for the manner in which he has conducted his campaign for new memberships in the association. Such efforts are not forgotten and they have brought out the commanding personality and efficiency of the chairman of the committee. We wish to command to the attention of the association the untiring efforts of Mr. J. A. Nyberg, of the Hyde Park high school, Chicago, for his wonderful success in securing a magnificent number of advertisements contained in this meeting's year-book as it was only through his efforts that the year-book, as we now have it, could be issued, and we sincerely hope that he will continue another year in this office. The efforts of Mr. Gingery of the Shortridge high school in perfecting local arrangements for the entertainment of the association cannot be forgotten and we heartily thank Mr. Gingery for the manner in which he has seen to the comfort of the association.

Resolved, too, that we greatly enjoyed and appreciated the music by the Shortridge orchestra under the leadership of Mr. C. E. Palmer. Rarely has one listened to such a splendid high school orchestra. To Miss Martha Hunt, of Shortridge, we wish to acknowledge our enjoyment of the magnificent reception tendered the association Friday afternoon, this appreciation includes all her helpers and the fine musical talent who rendered such splendid music for the occasion.

Still further resolved that we compliment those who had in charge the arrangements for the two magnificent excursions enjoyed by members of the organization. Furthermore we wish to extend our appreciation to Dr. R. L. Foley, of the State University, on his magnificent lecture on some recent researches and acoustics with demonstrations. Rarely have people been able to enjoy and appreciate such an effort or to enjoy such a lecture.

To Dean A. A. Potter, of the School of Engineering, Purdue University, and Dean Charles P. Emerson, M. D., of the Indiana University School of Medicine, we wish to extend our hearty thanks for the splendid educational address presented to the association Friday. To all speakers on the program our thanks are hereby acknowledged for their time and

energy expended in the interests of spreading the gospel of good science and mathematics instructions.

To our retiring treasurer, Mr. R. N. Van Hise, of the Chicago Normal College, we wish to extend our appreciation in the manner in which he has fulfilled his duties in securing new members, getting old members to pay their dues, and the splendid way in which he has managed the affairs of his office. Likewise to Mr. Glenn W. Warner, secretary of the Englewood high school, we wish to thank him for the magnificent manner in which he has conducted the affairs of his office, never lacking in any detail, present at all executive meetings, and showing not only an interest in the association but a complete knowledge of all the intricacies of this important position. To the retiring president, Mr. Frank B. Wade of the Shortridge high school, we most heartily extend our thanks and great appreciation for the interest he has shown in the association and for the magnificent executive ability which he has shown in conducting the affairs of his office. He has completely mastered the affairs of the president's office and without question, future results will show that he has been upheld not only by the present members of the association but many new ones which will surely connect themselves with this organization.

To the citizens of Indianapolis, we wish to acknowledge our indebtedness for the very courteous treatment they have rendered to us during this meeting under all circumstances. The keys of the city have really been in our hands, and we surely hope that Indianapolis will soon invite us to come again. CHARLES H. SMITH, Chairman

NECROLOGY COMMITTEE.

During the past year three of our members have "passed on."

J. A. Stoneking, of the Englewood high school, Chicago, died Feb. 17. Mr. Stoneking was born in Ripley County, Indiana, and was educated at the State University, Bloomington. After graduation for several years he was instructor in Physics in the University of Indiana and also at the University of Illinois. Ten years ago he came to Chicago as instructor of Physics in the Wendell Philips high school. He was a strong teacher excelling in lecture work. He was a man who made and held strong friendships.

Harry F. Day died Dec. 4, 1922, aged 32. For six years he taught in the Central high school, Kalamazoo, Mich., the last three years being head of the science department. He was a member of the Central Association for three years. One of his colleagues writes, "He was a man of great worth dependable and charitable. He was an admirable and efficient member of the faculty. He always did his work in the true light of an educator."

Wm. M. Butler, Principal of the Yeatman high school, St. Louis, Mo., was born Dec. 13, 1856, and died March 29, 1923. For nearly fifty years he had taught in the St. Louis schools. For many years he taught Physics in the Central and McKinley high schools. For fourteen years he was Principal of the Yeatman high school, and the acknowledged educational leader of north St. Louis. He was a member of the Central Association of Science and Mathematics Teachers almost from the beginning and for many years took an active part in its activities.

The writer of this note made his acquaintance twenty years ago when he first joined our association. During these years as we came to know him better our admiration of his many qualities grew deeper and deeper. A friend writes, "Chief among his many admirable character-

istics was an inflexible honesty—honesty in thought, in deed, in duty, and in life. Truth to him, was a prime essential to all character."

C. M. TURTON, Chairman.

REPORT OF AUDITING COMMITTEE.

We have examined the books and accounts of the Treasurer of the Association of School Science and Mathematics Teachers for the year ending September 30, 1923. We hereby certify that the cash receipts and disbursements, as shown by the records, are properly accounted for, and that the balance on hand September 30, 1923, of $578.95, is correct.

We find the books in most excellent order, and believe that the Association is greatly indebted to Mr. I. N. Van Hise for his faithful services as its treasurer.

Respectfully submitted,

R. W. OSBORNE, Chairman.
GERTRUDE L. ANTHONY.
W. S. McGEE.

MINUTES OF THE CHEMISTRY SECTION, FRIDAY AFTERNOON, NOVEMBER 30, 1923.

The meeting was called to order in Room 29 of the Shortridge high school, Indianapolis, by the Chairman, W. R. Teeters of the Soldan high school, St. Louis, Mo.

The first paper was read by A. D. Thoburn of the Swan-Meyers Co., Indianapolis, and was entitled, "John Dalton, His Personality." In a most interesting way Mr. Thoburn told us of the facts he had unearthed in the records of the "Literary and Philosophical Society," of Manchester, England. Dalton served as president of this society, and they have preserved a number of his lectures, notes and diaries. They also have some of his apparatus. The address was illustrated and gave us a fine idea of Dalton's work and character both by word and picture.

T. D. Kelsey of the Cleveland high school, St. Louis, Mo., then talked to us on the "Social Values of High School Chemistry." He pointed out that after all character building is the greatest achievement of the teacher. This view is upheld by business executives and the World Conference on Education. The Chemistry teacher may help the pupil to attain the primary and secondary virtues because his subject should develop love of truth, the spirit of open mindedness, honesty, regard for the rights of others, spirit of willingness to serve, and give moral and social training through study of the great leaders in Chemistry.

"The Necessity of Chemistry in High School Training" was the title of a paper read by Chester A. Amick, Technical high school, Indianapolis. In this he pointed out not only the value of the subject from an educational standpoint, but also from the point of view that there is no realm of life that Chemistry does not touch. The subject matter may now be put to countless practical uses.

Then an informal exchange of views on laboratory management, notebooks, papers, etc., was held. It was suggested that the subject could be made more interesting by the use of projects connecting Chemistry with outside life, simple analysis of various preparations on the market, charts, magazines and courses adapted to the special needs of the students. A bulletin board can be used effectively if students know a question on the quiz is to come from that material.

It was pointed out that we need to guide them a great deal in the matter of outside reading because so many fakes are printed. The students should be taught not to take too much on faith, but to test out things in the laboratory and thus gain first hand information.

While this outside work is good, it was brought out in discussion that we must stress the fundamentals. If we succeed in drilling these in, the colleges will not have to make special provisions for those who did not make good in high school.

Someone raised the question of how we could make pupils study. Various suggestions were made—assignment made just day before the recitation, a five-minute quiz at the beginning of each period, a quiz at the beginning of laboratory to see if pupils know what they are about to do, written preparation.

As the hour was late the chairman drew the discussion to a close and appointed the following nominating committee: H. R. Smith, Lake View H. S., Chicago, chairman; C. A. Amick, T. D. Kelsey.

The meeting was then adjourned.

SATURDAY MORNING, DECEMBER 1, 1923.

The meeting was called to order at 10 a. m. by the chairman. Louis E. Walton, of the Elyria high school, Elyria, Ohio, reported on the work that he and Earl R. Glenn of the Lincoln school, New York, have done to formulate some standard tests in Chemistry. These tests have been prepared for thirty-six topics or units and are constructed from high school texts. They cover vocabulary, important facts and laws, history and biography, application of principles in daily life, and problems. The questions are of five types: 1. Completion of statement; 2. Recognizing correct word; 3. One word answer; 4. Matching question and answer; 5. True—false type. Thirty-three schools have given these tests, but the co-operation of more is needed. Use them because they are the only ones and thus help to make better ones.

John R. Kuebler, Shortridge high school and member of the National Committee on Chemical Education of the American Chemical Society, read a paper called "A Standard Minimum Course in Chemistry for High Schools." This standard course has been worked out to encourage teaching, to fit both college and non-college students, taking into account both content and method, and to be of such a nature that colleges would recognize it. Mr. Kuebler said the report was given in full in the November School Science and Mathematics and asked that each teacher read it carefully and criticize it. Teachers in Ohio, Indiana and Missouri are to send their criticisms to Frank B. Wade, Shortridge high school, Indianapolis, and those in Illinois and to the north to Prof. B. S. Hopkins, University of Illinois, Urbana, Ill. The success or failure of this work depends on the acceptance of the report by the teachers.

After some discussion of the papers, the report of nominating committee was read and accepted:

Chairman, Clarence D. McLouth, H. S., Muskegon, Mich.

Vice-Chairman, Margery Stewart, New Trier Township H. S., Kenilworth, Ill.

Secretary, Sylvester Moore, Arsenal Technical H. S., Indianapolis.

Mr. Brown, of W. M. Welch Co., presented their new periodic chart, and then the meeting was adjourned.

GEOGRAPHY SECTION.

The meetings of the Geography Section proved decidedly worth while despite the small number who were present.

The Friday afternoon program consisted of four papers:

1. Geographical Distribution of Drug Plants by John S. Wright, of the Eli Lilly Company, Indianapolis.

2. Correlation of Subject Matter and Method in Normal School

Geography as Illustrated by the Geography of a City by Elizabeth Zachari, Department of Geography, Louisville Normal, Louisville, Kentucky.

3. The Louisville Investigators Council—a Junior High School Project, by Winifred D. Broderick, Department of Geography Training School, Louisville Normal.

4. A Geographic Field Trip to the Colorado Rockies by F. J. Breeze, Department of Geography, State Normal School, Muncie.

Mr. Wright's carefully prepared paper was accompanied by many maps which he had made by way of showing distribution. These added greatly to the interest as he took his listeners over the world in search of the homes of our more common food and drug plants.

The papers of both Miss Zachari and Miss Broderick were reports on results of their own practical experimentation. Each showed excellent illustrative material which had been worked out and used in the problems under discussion.

Mr. Breeze reported informally on his most recent field experience. In this he explained his methods of meeting the various problems of such work, summed up what he believes to be some of the worthwhile reactions from students in the field, and exhibited snap shots to substantiate his claim that by such cooperation as a group students can see at first hand what might be denied the individual because of the great expense of travel.

Saturday, by way of experiment, an all day field trip to Bloomington (seat of the State University) and return was substituted for further in-door discussion. The sixteen people who ventured to try this, led by Dr. William Tucker, of Indiana University, traveled through some of the most interesting of the State's territory. The route chosen crossed the Shelbyville Moraine, led past an old glacial lake bed, and into territory remarkable for its examples of the work of ground water—a region of sink holes and caves. Dr. Tucker so timed the various stops and discussions that each had opportunity to observe the outstanding features and was able, with a little guidance, to work out the big relationships of those features.

The climax of the trip came in the exploration of one of the larger of the caves near Bloomington. From Bloomington the return was made to Indianapolis in time for those from out of town to catch their out going trains.

The officers for the next term are:

Chairman, Mary Robb, Hyde Park high school, Chicago.

Vice-Chairman, Winifred D. Broderick, Louisville Normal, Louisville.

Secretary, Harry Wood, Senn high school, Chicago.

MABEL WASHBURN, Secretary.

Minutes of the Mathematics Section, Friday Afternoon, November, 30.

Mr. E. L. Thompson of Joliet, Illinois, presided. The first of the program consisted of an illustrated lecture presented by Miss Edith Inks of the Oak Park River Forest High School on "Geometrical Figures in Nature." Miss Inks showed how slides illustrating types of architecture, bridge building, art, design and nature in the leaf arrangements etc., of its plants, could be used in teaching practical applications of geometrical form.

The chairman appointed as Nominating Committee, to meet with similar committees of other sections, so as to distribute the officers of all sections over a larger territory, Mr. W. G. Gingery, Mr. E. B. Lytle and Mr. W. W. Gorsline.

The entire set of back numbers of School Science and Mathematics makes the most valuable help on modern and progressive Science and Mathematics teaching which is possible for one to possess. See price list on inside back cover.

Fifty cents each will be paid for back numbers of May, 1902, Vol. II, No. 3.

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Americans living or visiting in Italy and other persons interested in the literature of the United States have access to American books, magazines, and newspapers through the Library of American Studies at Rome, an institution founded and maintained by private subscription but open to the public without charge. More than 10,000 books are in this library, as well as newspapers from every part of the United States and more than 60 important literary, political, scientific, and other periodicals.

Mr. Hart then spoke on "Study of Problems connected with the Teaching of Mathematics." This paper was a report on the results gleaned from a questoinnaire drawn up and sent out to each member of this section by a Steering Committee consisting of Messrs. W. D. Reeve, M. J. Newell and W. W. Hart. The purpose of this committee was to "promote the study of, gather data about, and stimulate discussion of matters essential to the organization of courses in Mathematics in grades 7-12 inclusive." (See "Organization of Courses in Secondary Mathematics," School Science and Mathematics, XXIII: 638, October, 1923.)

Inasmuch as only forty-four replies were received to this questionnaire, due to the late date at which they were received, Miss Gugle requested that more time be given to digest the same.

Miss Kate Wentz of Indianapolis then led a discussion concerning "Hurdles—a Device for Determining the Degree of Mastery." This device is used in all high schools in Indianapolis. She presented sample tests, told how and when they were given, how they determined the grade of the pupil and discussed the value of the tests.

A discussion followed concerning time limits set on tests repetition in giving them, effect of Hurdles on teaching the subject and Hurdles as a means of placing responsibility on the pupil. Some of those participating in the discussion were Mr. E. L. Thompson, Mr. W. W. Hart, Mr. E. H. Slaught, Mr. E. B. Lytle.

Mr. Hart then requested that the group decide whether they wished to (1) take up the series of resolutions and pass them, (2) lay them on the table, or (3) have them submitted again with enough time for reflection and reported on next year.

It was moved and seconded that the committee be continued for another year and that their course of action be left to their own judgment.

Mr. Schorling suggested that a curriculum could not be built from only the judgment of teachers but also of necessity from actual experience and trial.

A motion to endorse the resolutions submitted was made and carried.

Mr. Slaught then mentioned the fact that Mr. Hart and his committee were continuing to carry through the early policy of the section. He congratulated the section on its twenty-third birthday and was certain that if a resumé of the meetings were made it would show that much had been accomplished in these years.

The meeting adjourned.

SATURDAY MORNING, DECEMBER 1.

Mr. E. L. Thompson, the chairman, presided.

Mr. W. W. Gorsline, of Crane Junior College, Chicago, spoke on "The Slide Rule in Secondary Schools." He submitted a report of a committee of the Chicago Men's Mathematics Club, taking up in detail the use of the slide rule in 2A Geometry.

The second paper of the morning was a most interesting discussion of the mathematics course of the senior high school given by Mr. Fiske Allen of the Training School, Eastern Illinois State Teachers College, Charleston, Illinois.

A brief discussion fo[illegible]d these papers.

The chairman then [illegible] for a report of the nominating committee, which was made by [illegible]G. Gingery of Indianapolis. The following nominations were mad[illegible]or chairman, A. M. Allison, Lakeview high school, Chicago; for vice-chairman, Raleigh Schorling, of University high school, Ann Arbor, Michigan; for secretary, Miss A. Blanche Clark,

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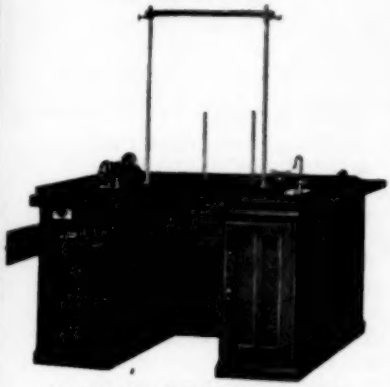

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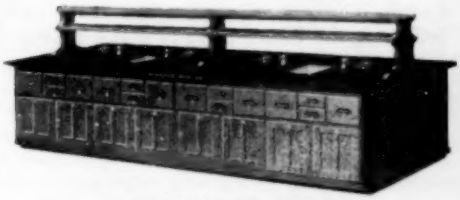

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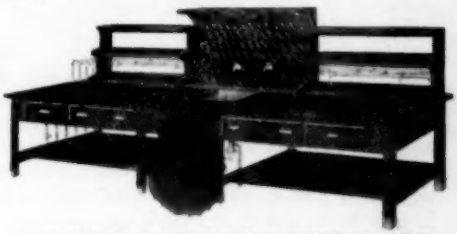

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high school, Rockford, Illinois. The report was accepted and the nominees duly elected.

The meeting adjourned.

MARTHA HILDEBRANDT, Secretary.

MINUTES OF PHYSICS SECTION.

The physics section of the S. A. S. and M. T. met in one of the physics laboratories of the Shortridge high school, Indianapolis, November 30, 1923. The room was filled to its capacity.

The meeting was called to order by Mr. W. C. Hawthorn, of Crane Junior College, Chicago, who appointed Mr. A. W. Augor, of the Tilden high school, Chicago, secretary pro tem in place of Alfred B. Bjorkland, who was necessarily detained at home.

The first paper presented was one by N. Henry Black of the Roxbury Latin school, Boston, on "Some Fads and Fancies in Physics Teaching." He presented a very interesting and helpful paper. It will appear in this journal in a future number. The second paper was read by Earl R. Glenn of the Lincoln School Columbia University, New York City, on the "Study of a New Series of High School Physics Tests for Instructional Purposes."

A Nominating Committee was appointed consisting of John Skinner, Charles H. Smith, and Charles L. Brosey.

This committee reported on their deliberations at the banquet held at the Spink-Arms hotel that evening. The following officers were elected:

Chairman, Miss Aleta McEvoy, high school, Rockford, Ill.; vice-chairman, Alfred Bjorkland, Harrison Tech. high school, Chicago; secretary, G. B. Eisenhard, Culver Military Academy, Culver, Indiana.

At the end of the reading of Mr. Black's paper the meeting adjourned to a larger room where, after considerable manipulations of the lights and lanterns, Mr. Glenn's paper was listened to.

Saturday morning at 10 o'clock the section proceeded by motor cars to Bloomington, the seat of the University of Indiana, where the men listened to a very interesting lecture by Dr. Foley on the "Visibility of Sound Waves." Considerable time was spent in inspecting the physics building, the entire physics corps acting as hosts. Dr. Foley presented many striking physical demonstrations of the common physical laws. The simplicity and beauty of those experiments aroused the enthusiasm of all present. The section then adjourned to their automobiles, which arrived in Indianapolis soon after six o'clock, when we adjourned for our homes.

A. W. AUGOR, Secretary.

LOW STOMACH IS BEST, SAY DOCTORS.

A low stomach insures good digestion. So say Drs. R. O. Moody, R. S. Van Nuys, and W. E. Chamberlain, who have made a study by X-ray and other modern methods, of the location of the stomach and other abdominal organs in 600 healthy students of the University of California. They have found that when the stomach extends downwards to from one to three inches below a line drawn around the body over the tops of the hip bones, the fortunate possessor of such an organ seldom has to have recourse to indigestion tablets. Eighty per cent of healthy persons examined had such stomachs.

This location has formerly been considered low by doctors and surgeons who have had to do chiefly with unhealthy stomachs. The present study is said to be the first which has been made on any considerable number of healthy persons, and it also indicates that the position of the abdominal organs cannot be altered by any system of diet, rest, or exercise.

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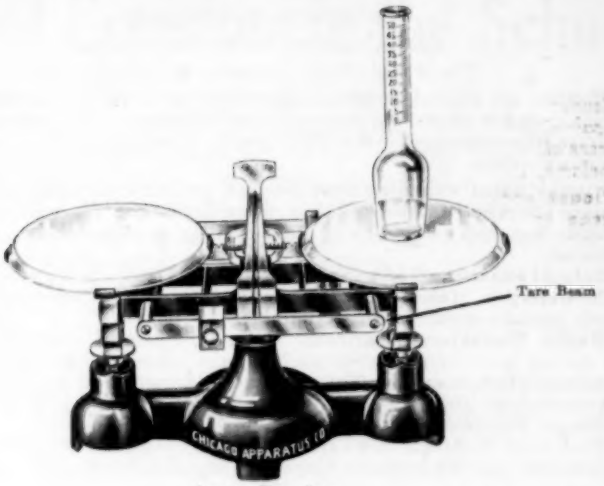
ARTICLES IN CURRENT PERIODICALS.

Education, for December, *Boston, Mass.* $4.00 a year, 40 cents a copy.
Matthew Arnold, the Educator, Florence L. Ingram.
Putting Aristotle Into the Machine Shop, Edward S. Cowdrick.
Dramatics as a Factor in Education, Joseph H. Benner.
First Aid in Americanization, J. W. Howerth.
Vocational Guidance, Lyrra H. Kennedy.
Journal of Geography for November, *Chicago, Ill., at 2249 Calumet Avenue.* $2.00 a year, 25 cents a copy.
Studies in the Geography of Brazil. William H. Haas.
Brazil's Foreign Trade, George R. Coxe.
Nature-Study Review for November, *Ithaca, New York.* $1.50 a year, 20 cents a copy.
Trees to Plant at School on Arbor Day. G. Vaughn.
Winter and Spring with my bees, H. L. Sherwood.
Weighed in the Balance, M. F. Barrett.
The Longleaf Pine. W. Bailor.
Photo-Era for December, Boston, Mass. $2.50 a year, 25 cents a copy.
Sub-Amateur, W. L. Hartshorn.
The Lure of Snow-Pictures, Charles H. Partington.
Kinematography for the Amateur, Part II, Herbert C. McKay.
Photo-Etchings of the California Desert, Eloise Roorbach.
The San Francisco-Oakland Salon, John P. Edwards.
The Point of View, E. L. C. Morse.
Popular Astronomy for December, *Northfield, Minn.* $4.00 a year, 50 cents a copy.
Photograph of the Solar Corona, plate XXXVI.
University of Arizona Eclipse Expedition, with plate XXXVIII, A. E. Douglass.
Total Solar eclipse observed from U. S. Navy airplanes.
Solar Eclipse photography. A forerunner of the motion picture camera, Millicent T. Bingham.
Louis Bell, with Plate XXXIX, Edward S. King.
Notes from "The Stone of the Sun" and the first chapter of the history of Mexico, Leah B. Allen.
Thirtieth meeting of the American Astronomical Society. (Continued.)
School Review for December, *University of Chicago Press.* $2.50 a year, 30 cents a copy....
Supervised Study in Mathematics, E. R. Breslich.
The Principal's Load, Rolland R. John.
Instructional Supervision with the Announced Visit as an Important Factor. A. G. Yawberg.
Voluntary Supplementary Studies in Nutrition, Mata Roman.
The High-School Teacher and Athletics, C. M. Howe.
Scientific Monthly, for January, *Garrison, New York.* $5.00 a year, 50 cents a copy.
Heredity of Embryonic Characters, T. H. Morgan.
Politics and Science, John A. Fairlie.
The Dog as a Detective, Dr. Wallace Craig.
Plant Life of British India, L. A. Kenoyer.
The cult and early economic organization, Herbert M. Diamond.
Language as a factor in human evolution. Ralph E. Danforth.
John T. Gulick, a contributor to evolutionary thought, Dr Addison Gulick.
The Growth of the Telescope, Major William J. S. Lockyer.
Torreya, for October, Torrey Botomical Club, 8 West King St., *Lancaster, Pa.*
Additional Notes on Sonchus uliginosus, Harold Pretz.
Shorter Notes
A Woodland Plant becoming a Weed, Albert Hansen.
Some Botanic Garden Material for High School Work, R. C. Benedict.
High School Biology and the New York Botanical Garden, G. T. Hastings.
Proceedings of the Club.

Three Scales In One



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Radio Questions Wanted. John C. Packard wants to know why we do not have some questions on radio. Send in the questions.

Acknowledgments: The receipt of examination papers is gratefully acknowledged from:

Escola Polytechnica, Universidade do Rio de Janeiro.

Technical Institute of Tammerfors, Helsingfors, Finland.

Ministry of Education, Copenhagen, Denmark.

Questions for Solution and Discussion.

435. *From "The Cameo," La Fayette Motors Corporation, Milwaukee, Wis.*

"Were your La Fayette to run for 24 hours without stopping at 30 miles an hour, the water pump would pump 75,000 gallons of water, or enough to furnish a town of 800 people with water for one day."

Someone, please, verify these figures by giving us the water pumped in some town of 800 people. How much power does it require to operate the pumps?

Please answer problems numbered 436 and 437 in the following examination paper:

436. An inelastic mass of 12 pounds moving with a velocity of 25 feet a second hits squarely another inelastic mass of 3 pounds which is at rest, and the two masses then move on together. Find their velocity after impact.

437. Six 40-watt tungsten lamps are used 90 hours a month and an electric flat iron that requires 3 amperes is used 30 hours a month on a 110 volt current. Find the total cost of operation per month at 8 cents a kilowatt hour.

Examination paper, submitted by E. T. Smith, Salem, Ohio.

BIOLOGY.

Answer ten questions.

1. Name the eight phyla of the animal kingdom and give an example of each.

2. By sketches, compare the brains of the fish, frog, cat, and man. What is the significance revealed by this comparison?

3. What are the chief lines of evidence which support the theory that all new species arise from pre-existing forms? What is the name of this theory?

4. Name three functions of our nervous system.

5. Compare and contrast the human body with a machine.

6. Name the classes of foods. What is the function of each within our bodies? How many calories do we need daily? What is a balanced ration? Give an example of a proper ratio for a man's diet.

7. Of what is the human blood composed? What are the six functions of our blood? What is lymph? Its functions?

8. Name the nine systems of organs found in mammal. What are their functions? Are these functions performed by the amoeba? If so, how? What great biological principle has been operating to produce this change from the simple amoeba to the complex mammal?

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9. Define: Pleura, food, assimilation, stimulant, poison, gillrakers metabolism.

10. Formulate five good rules to follow, in order to maintain good health.

11. If you wished to overcome a bad habit, what steps would you follow?

12. How would a general knowledge of Biology benefit the mayor of New York City?

Solutions and Answers.

427. *Proposed by L. P. Ramenstein, Clinton, Iowa.*

It is stated that a certain car had reduced the diameter of (rear) wheels on their car, claiming that they thereby increased the power.

Is this true? If so, in what sense is this true?

An automotive engineer answered that the *torque* was unquestionably increased but that the *power* was not affected. The machine could keep going on a heavier road provided that the small wheels did not sink so deep that the machine could not travel at all. On the contrary, on a good road, with the same engine speed the car would travel slower. Has the *power* been increased?

BIOLOGICAL BUREAU STARTS NEW SCIENTIFIC FUR FARM.

A new experimental fur farm, stocked in part with unscented skunks, has just been established by the United States Biological Survey on a twenty-acre tract of wooded land in Greenfield Township, Saratoga County, New York. F. G. Ashbrook of the Bureau's Division of Economic Investigations has charge of the transfer of the animals from the former and more inaccessible site at Keeseville.

Present plans call for a series of modern pens to accommodate silver, black, and red foxes, martens, minks, fishers, and skunks. The breeding habits of these fur bearers will be studied and methods of combating disease among them will be worked out.

At Keeseville last year, martens were successfully bred in captivity for the first time. This work will be continued at the new site and efforts will be made to discover how to breed the fisher, another beautiful fur animal which has hitherto baffled the commercial raiser.

Experiments in fighting disease, such as distemper and hookworm, will be carried forward. Hookworm is one of the most prevalent diseases among captive foxes, and the Bureau has worked out an effective means of killing the parasites which produce it by use of the chemical, carbon tetrachloride.

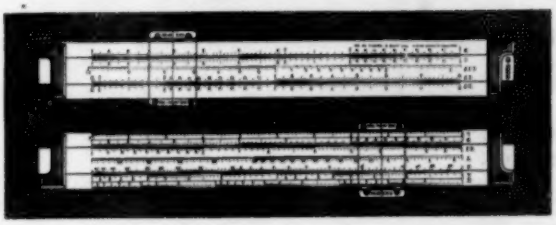
Much trouble was formerly had in administering this remedy, however, as the capsules in which it was given were often broken in the mouths of the foxes with the result that the carbon tetrachloride often went down their windpipes and suffocated them. Recently the investigators found that by use of a more gelatinous capsule which would mash without breaking, this trouble could be largely prevented. Methods of artificial respiration, similar to those used to revive an apparently drowned man, were also worked out by which the accidentally gassed foxes could be resuscitated.

The skunks raised on the farm have all had their scent sacs removed. This gland operation does not injure the breeding or fur value of these animals which have been held in such bad odor, but makes them more agreeable from an olfactory standpoint.

BOOKS RECEIVED.

Economics of the Family, by C. W. Tabor and Ruth A. Wardall, University of Illinois. Pages xii+216. 14x20 cm. Cloth. 1923. J. P. Lippincott, Chicago.

The Slide Rule in Trigonometry



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Twenty-Third Annual Report of the Director of Education, by the Government of the Philippine Islands. 163 pages. 18x25 cm. 1923. Paper. Bureau of Printing, Manila.

Catalogue of High School and College Textbooks, by Ginn & Company. Pages xx+402. A complete price list. 12½x19 cm. Paper. 1924. Ginn & Company.

Substance and Function and Einstein's Theory of Relativity, by Ernst Cassirer. Translated by William C. Swabey and Marie C. Swabey. Pages xiii+465. 16x23.5 cm. Cloth. 1923. $3.75. Open Court Publishing Co., Chicago.

The New Physics, by Arthur Haas, University of Leipzig. Translated by Robt. W. Lawson. Pages xi+165. 13.5x19.5 cm. Cloth. 1923. $2.50. E. P. Dutton & Co., New York.

How to Teach Physics, by Rogers D. Rusk. Northwestern College, Naperville, Ill. Pages x+186. 12.5x19.5 cm. Cloth. 1923. J. B. Lippincott Company, Philadelphia.

Sheet-Metal Work, by Marion S. New, Washington Junior High, Rochester, N. Y., and Verne A. Bird, Rochester, N. Y. 64 pages. 14.5x23 cm. Paper. 1923. 85c. Manual Arts Press, Peoria, Ill.

BOOK REVIEWS.

Twenty-Third Annual Report of the Director of Education, by the government of the Philippine Islands. 163 pages. 18x25 cm. 1923. Paper. Bureau of Printing, Manila.

A report which when read by educators of the United States will cause them to be surprised at the remarkable advance in the direction of education in the Islands fostered by the United States government. The report goes into considerable detail as to the manner in which educational matters are handled. It is well illustrated from actual photographs of pupils in action, various schools, and out-door life. There are many tables of statistics incorporated in the report, dealing with all lines of work in the Archipelago. The reading of this book ought to convince any one with intelligence that the very best thing that can happen to the inhabitants of these islands is for this government to retain control over them.

C. H. S.

The Investigation of the Written Examination as a Measure of Achievement with Particular Reference to General Science, by Joseph Bardy. 176 pages. 16x24 cm. Cloth. 1923. Banta Company, Menasha, Wisconsin.

This is a thesis prepared by the author for his Ph.D. degree. The author has investigated very thoroughly not only the effect of written tests in general science especially but upon the value of said tests to the pupils. The author corresponded with the long list of high schools from one end of the country to the other and had a remarkable number of replies to his requests; sufficiently so that he was able to draw from definite conclusions with reference to the matter under investigation. He devotes some space to the method of scoring examinations and other very interesting data. There is appended a long bibliography. It is a splendid investigation of this subject and any teacher of general science will be well paid to invest in a copy.

C. H. S.

The Teachers' Manual for McMurry and Parkins' Geography, by A. E. Parkins, Peabody College for Teachers. 55 pages. 20x25½ cm. Paper. 1923. The McMillan Co., New York City.

This is a splendid little book, prepared especially to assist teachers in instructing in geography work, especially with the author's geography. It gives in a brief way the subjects that should be discussed in high school

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work in geography. There are a great number of tables appended bearing directly upon the work in question. There is also given a list of books for reference libraries, also a list for teachers' library. All geography teachers should possess a copy. C. H. S.

Every Day Mysteries, by Charles G. Abbot, Secretary of the Smithsonian Institute. Pages ix+198.

A book prepared especially for the ordinary layman with special reference to affairs centered around the home. One cannot go into the minute details of the description of the book any more than to remark that many of the things that trouble the home keeper may have them explained by becoming familiar with this book. There are many practical suggestions as, for instance, how sun makes the plants grow, fixing a clock, cooking by the sun's rays, etc.

The book is well written and cannot help but interest any person who has the interests of home at heart. C. H. S.

A Catalogue of High School and College Textbooks, by Ginn and Company. Pages xx+402. A complete price list. 12½x19 cm. Paper. 1924. Ginn & Company, Boston.

There has recently come to the editor's desk a complete catalogue of high school and college textbooks published by one of the most enterprising book companies in the world. The catalogue is gotten out not only to serve the publisher's interests but more particularly to conserve the time of the teachers, school boards, and purchasers of textbooks. It is splendidly arranged. There is given for each book a short synopsis of what is contained therein, the price, etc. Boards of education contemplating the introduction of new books into their curriculum should send for a copy of this catalogue before purchasing. The price of the various books is given in a small pamphlet of fifty-eight pages, accompanying the catalogue. C. H. S.

Laboratory Experiments in Practical Physics, by N. Henry Black, Roxbury Latin School, Boston, Mass. 243 pages. 13x19½ cm. Cloth. 1923. MacMillan Co., New York City.

This is one of the newer manuals that has been gotten out for experimental work in physics. It is a good book on the subject and has the usual number of experiments that most all the good laboratory manuals possess. It does the so-called classical experiments and contains very little that is new in the direction of secondary school physical laboratory work. The method of presentation is, however, different and is truly fine. There are sixty-five (65) different experiments. Each experiment closes with a number of practical questions bearing upon the work in that experiment. The cuts, of which there are one hundred thirty-two (132), are splendid. It can be made to fit almost any laboratory that is fairly equipped with physical apparatus.

No physics teacher can do better than to follow it out and thus save much labor in writing his own experiments. It is well printed, well written, well bound, and will stand hard usage.

C. H. S.

First Book in Arithmetic, by Harry Brooks, John Cheverus School, Boston. Pages xiv+134. 13x19 cm. 70 cents. 1923. Little, Brown, and Company, Boston.

This is the first of a two-book series. It is foruse in grades four, five and six, covering the essentials of arithmetic and including all subjects which the author considers of practical value to the pupil in after life. The work is based on the inductive method and as far as possible makes the text itself the teacher. Each chapter contains the teaching lesson, oral problems based on the principles taught in the lesson, written prob-

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lems, a review of the tables in the teaching lesson, and a summary of the different principles involved in the chapter.

H. E. C.

Junior High School Arithmetic, by Harry Brooks, John Cheverus School, Boston. Pages xiv+195. 13x19 cm. 80 cents. 1923. Little, Brown, and Company, Boston.

The plan of this book is the same as for Book I, and the development and sequence of the subject matter is one of the important features. The text is addressed to the pupils in a way to make them feel that they are their own masters, and to give them opportunity and power for self-direction. The suggestions to teachers are valuable. Each of the books contains over 1300 concrete problems, and no conundrums.

H. E. C.

First Course in Algebra, by Edward I. Edgerton, Dickinson High School, Jersey City, N. J., and Perry A. Carpenter, West High School, Rochester, N. Y. Pages vii+392. 13x19 cm. 1923. Allyn and Bacon. Boston.

There are several interesting features in this book. The logical sequence and natural development of each topic from the immediately preceding, and the explanations given in detail and in the simplest language should make it easier for young pupils to understand the subject. The numerous oral exercises and review examples are very helpful. The formula is emphasized throughout and there is a large number of geometrical applications. Operations with complicated forms are omitted.

H. E. C.

Plane Geometry, Revised Edition, by John W. Young, Professor of Mathematics in Dartmouth College, and Albert J. Schwartz, Instructor in Mathematics in the William McKinley High School, St. Louis, Mo. Pages x+278. 13x19 cm. 1923. Henry Holt and Company, New York.

The first forty-two pages give not only systematic work in geometrical drawing but also give the pupils an easy approach to the idea of developing formal proofs of theorems. This work is exceptionally good. There is a large number of exercises and problems, and many suggestions aiding the pupil to think over the given conditions and build up his own proof. The definitions and elementary applications of the trigonometric functions and in the appendix a short chapter on the solution of triangles furnish ample material for an introduction to trigonometry.

H. E. C.

Junior High School Mathematics. Book Three, by Walter W. Hart, Assistant Professor of Mathematics, University of Wisconsin, School of Education, Pages ix+346. 13x18 cm. 1923. D. C. Heath & Co., New York.

Since this third book of the series is quite complete in itself it can be used to great advantage in the highest grade of the junior high school or the first year of the four-year high school. It furnishes a minimum course which every class can master easily in one school year and much supplementary material for pupils and classes of more than average ability. All the work is well planned; careful instruction on one new idea at a time, emphasis on thoughtful solutions rather than on rapid mechanical operations, systematic instruction in the solution of problems, the gradual development of the function concept in connection with the use of formulas, graphs and the evaluation of expressions. This series deserves the careful attention of teachers of junior high school mathematics.

H. E. C.

The Progress of Arithmetic, by David Eugene Smith, Teachers College, Columbia University. Pages vi+93. 14x21 cm. 72 cents. 1923. Ginn and Company, Boston.

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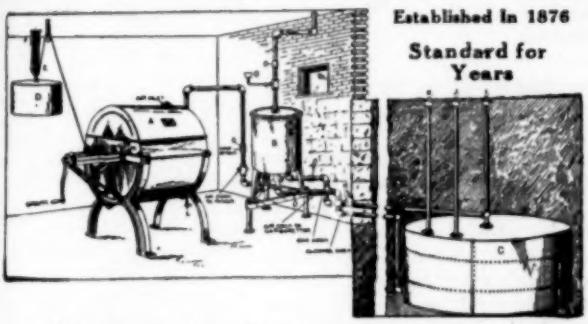

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Essentials of Plane and Solid Geometry, by David Eugene Smith. Pages x+504. 14x19 cm. 1923. Ginn and Company, Boston.

This textbook of demonstrative geometry proceeds at once to its purpose of giving the student an insight into deductive reasoning. Among the special features mentioned are the selection and arrangement of propositions, the simplicity of language and of proofs, the introduction to independent demonstration, the statements of the plan of proofs, the applications, the improved typography, and the emphasis secured by the framing of diagrams. H. E. C.

Plane Trigonometry, by Paul R. Rider, Ph.D., Associate Professor of Mathematics, Washington University, St. Louis, Mo., and Alfred Davis, M. A., Head Assistant, Department of Mathematics, Soldan High School, St. Louis, Pages xi+280. 14x20 cm. 1923, D. Van Nostrand Company, New York.

A large number of good problems including many useful applications, surveying, parallel sailing, middle latitude sailing, components and resultants of forces and of velocities, makes this an excellent textbook. The explanations are full and clear, the scheme of arrangement of computations and methods of checking are emphasized, and all worth while topics are included. The usual tables of logarithms and natural functions are not given in this text. H. E. C.

Projective Geometry, by Peter Field, Professor of Mathematics, University of Michigan. Pages viii+98 14x21 cm. $2.00. 1923. D. Van Nostrand Company, New York.

This volume which emphasizes the technical applications of projective geometry furnishes a most excellent course for engineering students. It fills in the gap between textbooks written from the viewpoint of pure mathematics and the textbooks of technical mechanics which usually assume on the part of the student a knowledge of some of the fundamental theories of projective geometry. Among the subjects treated are plane homology, linkages, the complete quadrangle and quadrilateral, the cross-ratio, ranges and pencils, the hexagon, involution, pole and polar, and the null system.

H. E. C.

Synopsis of Applicable Mathematics, by L. Silberstein, Ph.D. Pages xi+250. 14x22 cm. $4.50. 1923. D. Van Nostrand Company, New York.

The first part contains tables of logarithms of numbers and trigonometric functions; in the latter table the subdivisions are tenths of degrees. The second part contains a collection of mathematical formulas, definitions, theorems, and tables which will meet the every-day needs of workers in mathematics and physics. Some of the topics covered are permutations; interpolation; determinants; complex numbers; infinite series; infinite products; transcendental numbers; exponential, logarithmic, trigonometric and hyperbolic functions; limits; Fresnel's integrals with tables; the error function with tables; the gamma function; Fourier series; spherical harmonics; and Bessel functions. There are brief but system-

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H. E. C.

From Determinant to Tensor, by W. F. Sheppard, Sc. D., LL.M., formerly fellow of Trinity College, Cambridge. Pages 127. 13.5x19.5 cm. $2.85. 1923. Oxford University Press American Branch. New York.

The first four chapters deal with the elementary theory of determinants; then follow chapters on the tensor notation, sets of quantities, related sets of variables, differential relation of sets, examples from the theory of statistics, and tensors in the theory of relativity. While the book might be used as an introduction to the mathematical theory of relativity, the author prefers to consider it an exercise in the application of methods which, apart from any practical use, possess a special beauty of their own.

H. E. C.

Vector Analysis, by C. Runge, Professor of Mathematics at the University of Göttingen. Translated by H. Levy, M. A., D. Sc., F. R. S. E., Assistant Professor of Mathematics at the Imperial College of Science, London. Pages viii+226. 14x19 cm. $3.50. E. P. Dutton and Company, New York.

In the present work the author has planned to correlate the customary conceptions of vector analysis with the fundamental ideas of Grassman's treatment. This, the first volume, contains the vectorial analysis of three dimensions under the chapter headings, vectors and vectorial areas, the differentiation and integration of vectors and vectorial areas, and tensors. It is interesting to note that the diction does not suggest that it is a translation.

H. E. C.

Miller Mental Ability Test, by W. S. Miller, Ph.D., Professor of Educational Psychology, University of Minnesota. World Book Company, Yonkers-on-Hudson, New York.

This test is for grades seven to twelve and for college freshmen. Form A was reviewed a year ago. Form B is constructed so as to allow for practice effect when it is administered within two days after Form A has been given. This makes the norms for both forms the same without making the usual necessary adjustments. Net prices are: Manual of Directions 24 pages, twenty cents. Form A and Form B, $1.00 for twenty-five examination booklets including key, age-grade-score sheet and percentile graph. Specimen set, thirty cents.

H. E. C.

Charts and Graphs, by Karl G. Karsten, B. A. (oxon), Consulting Statistician. Pages xl+724. 16.5x23 cm. Flexible binding. 1923. Prentice-Hall, Inc., New York.

An interesting introduction by Carl Snyder, Chief Statistician of the Federal Reserve Bank of New York prefaces this volume on graphic methods in the control and analysis of statistics. The book shows how to make charts which put life into the dullest statistics. It covers all types of chart, graph and diagram, describing each in non-technical language and explaining the construction and use, with 498 illustrations reproduced. The author's statement that he has sought to tell the whole story of the chart in the simplest words that he can command, is verified by reading the text. Not only is the making of charts explained, but also there are illuminating discussions of the best form for particular classes of data, of the dimensions and variables which will cause the chart to represent accurately the facts, and of the use of various calculating charts. The usefulness of the book is enhanced by the table of contents, list of illustrations by chart-method, list of illustrations by subject matter, and a very complete index.

H. E. C.